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Volume 37, Number 1 January 2007

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ON THE COVER This impressive 11-centimeter-high gold specimen was mined at Round Mountain in Nye County, Nevada. (Jeff Scovil photo/Wayne Thompson Minerals specimen)

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The LEGACY of Pre-Columbian Gold Work

Its Beauty, Craftsmanship and Mystique Survive the Centuries

Story and Photos by Steve Voynick

Of the many types of AmerIndian artifacts—the material legacies left behind by the ancient cultures of the Americas—nothing quite matches the mystique, technical perfection, monetary value, and sheer magnificence of the gold work crafted by AmerIndian metalsmiths before the arrival of the Spanish.

Even though pre-Columbian gold work has not been fashioned for five centuries, it continues to make the news, usually in one of three contexts: the opening of a new museum exhibit; its recovery from newly discovered archaeological sites; or its seizure because of violations of antiquities laws.

Pre-Columbian gold work is a fascinating art form for two reasons. The first, as those who have seen gold-work exhibits will testify, is its beauty, craftsmanship, and sheer visual impact. The second is the remarkable story of how gold working originated, evolved technically, and spread among different cultures.

Over a period of three millennia—from 1500 B.C. to A.D. 500—many ancient AmerIndian cultures along a 5,000-mile-long stretch of South America and Central America created golden artwork. Encompassing broad variations in geography, time, artistic style, metalworking techniques, and intended purposes, this prolific production was made possible by abundant supplies of gold and a mastery of its metallurgy.

The first AmerIndian group to mine and work gold was the Waywaka culture of the south-central Andes region of Peru. Archaeologists have contextually dated Waywakan gold artifacts and gold-working implements, including pieces of delicately hammered gold foil and a metalsmith's tool kit, to 1500 B.C., making them the oldest ever recovered in the Americas.

Calima gold work was produced near the rich Cauca River placers and is characterized by gold of high purity.

The Waywakan interest in gold stemmed from the abundance of the metal in many streams that flow down from the Andes. With their steep gradients, coarse gravels, and huge variations in seasonal water flow, these streams formed incredibly rich placers that actually became visible on the surface during the dry season.

Gold's bright gleam and sunny color attracted the attention of the Waywakas, who soon discovered the metal's softness and great workability. Considering gold's remarkable malleability—it can be hammered to a thickness of just 1/300,000 inch without deteriorating—it is not surprising that the first Waywakan gold-working technique was hammering. Although a simple process, hammering demanded considerable skill. Only long hours of hammering with stone tools could create the broad, thin gold foils and sheets needed for breastplates, masks, and other large, complex objects.

Because extensive hammering also caused the gold sheets to crack, the Waywakas and other early Peruvian cultures devised an annealing, or tempering, process. After hammering, metalworkers

Gilded tumbaga, a 60:40 mixture of copper and gold, has the appearance of pure gold.

Tumbaga has extraordinary casting qualities and a rich reddish color.

This Calima breastplate of nearly pure gold combines hammering, casting and welding techniques.

heated the gold sheets over drafted charcoal fires, then quenched (cooled) them in water. Because annealing relieves internal molecular stresses, repetitive sequences of hammering and annealing would produce large, uniformly thin gold sheets free of cracks.

By 200 B.C., Peru's Chavin and Naca cultures had expanded the original Waywakan gold-working techniques to include etching, embossing and casting, innovations that helped to increase the understanding of gold metallurgy.

Peruvian gold is typically alloyed with substantial amounts of copper and silver, sometimes as much as 50 percent. Chavin and Naca goldsmiths learned to manage the varied workability of these natural alloys, and even to gild them with pure gold coatings. One interesting gilding technique employed mercury, obtained from the rich cinnabar (mercury sulfide) deposits at Huancavelica. Goldsmiths coated gold-alloy objects with a pasty amalgam of gold and mercury. Heating these objects then vaporized the mercury, leaving behind a dull-gray coating of particulate gold that could be melted into a uniform coating of bright-yellow metallic gold.

After A.D. 750, the Sican culture took the lead in gold working, mining huge quantities of gold from phenomenally rich placers along Peru's northern coast and producing large amounts of gold work. One recently excavated Sican tomb has yielded 330 golden objects, including elaborately etched jewelry pieces depicting images of rulers on thrones and divers gathering seashells. The most impressive piece is a royal gold cloak made of 2,000 individual squares of hammered gold foil "sewn" together with delicate gold wire.

Peru's placers, the first ever mined in the Americas, have been exploited over many centuries by AmerIndian, colonial and post-colonial miners. Some are still mined today, as are nearby, geologically associated hard-rock gold deposits. The old Sican placers are near Newmont Mining Co.'s Yanacocha open pit, currently the world's second-largest gold mine. Peru currently ranks as the world's fifth largest gold producer, with an annual output of 5.4 million troy ounces.

Pre-Columbian miners obtained most of their gold from placers and only small amounts from shallow underground workings that followed gold-quartz veins. Placer mining was quite advanced and employed ground-sluicing and stream-diversion techniques. During dry seasons, miners built stone riffle systems, then dug up placer deposits in dry riverbeds. When spring floods swept the river gravels downstream, the stone riffles trapped the gold. Miners then washed the recovered concentrates in large, concave wooden pans that the Spanish later called *bateas*.

continued on next page

The Legacy of Pre-Columbian Gold Work *from page 13*

Only cultures with high degrees of labor specialization engaged in gold working. In these cultures, mining and working gold were usually separate professions requiring separate skills. Miners had relatively low social status. Their work was primarily limited to recovering and trading raw gold, and what little gold work they made was crude.

Goldsmiths, however, enjoyed great prestige and were provided with life's necessities to enable them to concentrate on their craft. Their high social status was linked to the reverence for gold itself. Although lacking any utilitarian value, gold was considered so noble that only the finest art or the most sacred religious expression justified its use. In these pre-Columbian cultures, gold never became a symbol of wealth or a monetary medium. Because of its great beauty, workability and durability, the metal was valued on an emotional plane, much like love and happiness. Finished gold work was rarely traded, but used mainly in religious ceremonies, to adorn temples and altars, as personal symbols of royalty or status, to accompany the dead into their graves for use in an afterlife, or in sacrifices in deep Andean lakes.

Although gold working originated in Peru, it reached its peak of technological development in Colombia. Gold-working skills had begun slowly spreading north from Peru as early as 1000 B.C., reaching the Calima and Tumaco areas of southwestern Colombia about 200 B.C. Placer mining in Colombia's Cauca River Valley began shortly thereafter.

The Cauca River placers, along with nearby lode deposits, were important sources of gold. The richness and size of these deposits is reflected even today in Colombia's gold production: nearly 1.5 million troy ounces per year, enough to rank it 12th in world gold output.

By A.D. 800, Colombian metalsmiths had perfected brilliant refining, alloying, gilding and casting techniques. They refined naturally alloyed raw gold by mixing gold particles with common salt (sodium chloride), then heating the mixture to incandescence. The more chemically active metals present—primarily silver, copper, and iron—formed metal chlorides, which vaporized, leaving behind nearly pure gold.

Unlike Peruvian goldsmiths, those in Colombia first purified gold, then created their own specific alloys such as *tumbaga*, a 60:40 mixture of copper and gold. *Tumbaga* was harder than either copper or gold and had a pleasing reddish color, a low melting temperature, and extraordinary casting qualities.

With no mercury available, Colombian goldsmiths gilded *tumbaga* objects with the *mise-en-couleur* method. They heated *tumbaga* to redness to oxidize the surface copper, then removed the resulting black copper-oxide film with organic acids such as acetic acid, or vinegar, to leave a bright-yellow surface of pure gold.

Colombian goldsmiths also devised welding techniques with which to fabricate complex objects. They heated the edges of two adjoining sheets nearly to the melting point, then added a copper-acetate flux made by treating copper with vinegar. The result was an actual molecular fusion that made a strong, artistically perfect seam.

This stylized, hollow tumbaga casting of a frog is in the Quimbaya style of pre-Columbian gold work.

The finest pieces of gold work were cast in the lost wax, or *cire perdue*, process, in which detailed carvings of beeswax or palm wax were first enclosed in clay. Firing baked the clay and burned off the wax, leaving a hollow ceramic mold into which molten gold or *tumbaga* was poured. After solidification, removing the exterior mold revealed a solid piece of gold that precisely replicated the original wax carving. A more complex technique even produced hollow gold castings.

Today, Colombia's gold work is classified by artistic and technical similarities into seven cultural groups: Tairona, Sinú, Quimbaya, Calima, Tolima, Muisca and Nariño. In northern Colombia, the Tairona became known for gold nosepieces, earrings and pendants, and especially for realistic castings of human and animal figures, often frogs, the symbol of water and fertility.

Also in northern Colombia, the Sinú cast fan-shaped earrings and ceremonial staff ends in the form of eagle, reptile and jaguar heads. The Sinú also made large burial areas containing hundreds of graves with many golden funerary offerings. In the central mountains, the Quimbaya produced realistic, technically perfect, and elegant golden breastplates, bracelets, rings and brooches in the form of anthropomorphic and zoomorphic figures, as well as delicate filigree with precise angular intersections.

Along the central Pacific Coast, the Calima fashioned large artistic objects of high-purity gold, notably masks and breastplates, as well as elaborate necklaces of uniformly sized, hollow gold beads. Nearby Tolima goldsmiths used their mastery of lost-wax casting to create heavy, flat, angular representations of the human figure.

In the mountains near the modern capital city of Bogotá, the Muisca worked primarily in *tumbaga* and sacrificed much of their golden artwork into deep mountain lakes. Nariño metalsmiths in southwestern Colombia and adjacent Ecuador employed casting, hammering, gilding and wire techniques to fabricate pendants, nosepieces, earrings and rattles in geometric, stylized forms of animals.

Interestingly, local abundance or scarcity of raw gold influenced both metallurgical and artistic styles. As examples, Calima metalsmiths who worked near the rich Cauca River placers fashioned large pieces of artwork of nearly pure gold, while the Muisca, in the gold-poor central mountains, produced smaller objects of gilded *tumbaga*.

By 600 A.D., gold-working skills had begun spreading farther north into what is now Costa Rica. Prior to that time, jade had been the material of premier value among the cultures of Costa Rica and other Central American areas. Anthropologists believe that when gold work was introduced, these regional cultures faced an interesting choice.

The jade mined in pre-Columbian times in Guatemala and traded throughout Central America was jadeite, a sodium aluminum silicate containing some iron and calcium. Guatemalan jade had been mined and worked since 1000 B.C., most notably by Olmec stoneworkers. The Olmec civilization, Central America's first complex society, had emerged about 2000 B.C. and reached its peak of development from A.D. 300 to A.D. 600. The Olmecs were master sculptors who carved the blue-green and green Guatemalan jadeite into beads, pendants, celts (ceremonial ax heads), realistic human masks, and representations of deities and such magical figures as dragons. To Central American cultures, the greenness of jade represented water, fertility, vegetation, maize, and a link to ancestors.

In Costa Rica, gold and jade were perceived as opposites. Jade, obtained through trade from sources far to the north, was transformed into objects of art

by the simple, slow, labor-intensive, but readily comprehensible processes of cutting, flaking, grinding, drilling and polishing. Because drilling a single, long jade bead could take years, the time involved in the work gave jade objects much of their value.

On the other hand, raw gold was easily obtained in trade from Colombia or mined locally from small, rich placers. But the fabrication techniques that transformed raw metal into finished artwork were complicated and mysterious, requiring wax, copper, clay, chemical fluxes, furnaces, and, above all, highly specialized and uncommon skills.

In Costa Rica, gold finally replaced jade as the material of premier value and gold necklaces, bracelets, armbands, and pendants served as ornamentation for the common person.

By A.D. 1100, the reverence for gold and gold-working skills had spread north to southern Mexico where the Mixtec culture created flexible belts of cast gold chains that jingled when the wearer moved. The Aztecs, who rose to power in southern Mexico a century later, valued gold and jade equally.

When Christopher Columbus made his 1492 landfall at San Salvador, a central Bahamian island, he found natives adorned with simple, crudely fashioned ornaments of gold that had come from placers on the island of Hispaniola, 300 miles to the southeast. Anthropologists are uncertain whether gold-mining and gold-working skills originated independently on Hispaniola or were brought there from South America or Central America.

Upon reaching Central America in 1502 on his fourth voyage, Columbus encountered natives heavily adorned with finely crafted gold work. Impressed with the quantity of this gold, Columbus named the new land Costa Rica—"rich coast."

Columbus' voyages opened the door to the greatest cultural clash ever regarding gold. To the Spanish, gold represented the ultimate in material value and was something to be gotten by all means and at all costs. The Spanish looted 10 tonnes of gold work (310,000 troy ounces) from the Aztecs in Mexico and another 150 tonnes (4.6 million troy ounces) from the Incas in Peru. By 1540, the social infrastructures that supported AmerIndian gold working had been eradicated. The Spanish then systematically looted graves for nearly three centuries, melting down their vast trove of recovered gold work into coins and bars.

After 1821, when Spain's New World Empire collapsed, grave robbers continued to loot AmerIndian graves, melting down the gold work and selling it at bullion value. Only after 1900 did scholars, scientists, and collectors recognize the beauty, craftsmanship, and irreplaceable cultural value of pre-Columbian gold work. As collector demand grew rapidly, the worth of intact gold work soon surpassed its bullion value. Grave robbers then stopped melting down their recovered gold work, and instead sold it intact to foreign buyers who resold it to museums and private collectors abroad for huge profits.

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The Legacy of Pre-Columbian Gold Work *from page 15*

The drain of these irreplaceable cultural artifacts from their nations of origin continued unchecked until 1950, when the Banco Central de Costa Rica began to purchase gold work from grave robbers in an effort to protect the national patrimony. A decade later, Colombia became the first nation to prohibit the unauthorized excavation and export of pre-Columbian gold work. The Banco de la Republica, Colombia's national bank, also established the Museo del Oro (Museum of the Gold) to purchase—at a fair price and with no questions asked—all available gold work. In just three years, the Museo del Oro acquired 10,000 pieces of pre-Columbian gold work.

Later, a series of multinational agreements, mainly the 1970 UNESCO protocol on the trade of cultural property and the 1976 Convention for the Defense of Archaeological, Historic, and Artistic Patrimony of the American Nations, provided broader protection by banning both the export of cultural objects and their import into treaty-member nations. The 1976 agreement also provided authority for seizure and return of the objects to the nation of origin.

But that's not the end of the story of pre-Columbian gold, for its intrigues live on. Although unauthorized excavation of archaeological sites is now banned in all Latin American nations, soaring collector prices continue to sustain a booming black market in pre-Columbian gold work. As one example, after a major archaeological site in Peru was illegally excavated 15 years ago, a flood of illegal gold work reached the United States. To stem the trade, the U.S. and Peru signed a special bilateral agreement. Within just five years, federal agencies in the United States had seized 150 pieces of pre-Columbian gold work and returned them to Peru.

Museums must be particularly alert when purchasing or accepting donations of pre-Columbian gold work. Such transactions can involve hundreds of pieces. For example, the 2002 donation of the Alfred C. Glassell Jr. collection of 800 pieces of gold work to the Museum of Fine Arts in Houston, Texas, was legal because it had been imported into the United States years before the first restrictive laws were enacted.

A New Mexico museum, however, was not so fortunate. A visiting archaeologist recently noted that several pieces in this museum's pre-Columbian gold exhibit resembled the style of 1,700-year-old pieces that had been looted from Peruvian tombs several years earlier. He contacted federal agencies, which learned that the pieces had been donated by a wealthy private collector. Because the collector had purchased them from a dealer who had imported them *after* trade restrictions were in place, the pieces were seized.

Although pre-Columbian gold work is affordable only to wealthy collectors, everyone has the opportunity to view exhibits of the gold work. The three best places to do so are in the capital cities of Bogotá, Colombia; San José, Costa Rica; and Lima, Peru. In Bogotá, the Museo del Oro collection now numbers 33,000 individual pieces of gold work, 8,000 of which are superbly and dramatically displayed. In San José, Costa Rica's Pre-Columbian Gold Museum is a three-story underground museum that displays 2,000 pieces of gold work dating from A.D. 500 to A.D. 1500.

Peru has several museums that display pre-Columbian gold artifacts. The largest collection is the privately owned Peruvian Gold Museum, also known as Museo Muijica after its founder Miguel Muijica Gallo, a wealthy Peruvian who spent many years helping to save his nation's patrimony by buying excavated gold work from grave robbers and dealers. This museum does not meet formal museum standards of cataloging and documentation, but many of its 10,000 pieces of gold work are spectacular.

Colombia's Museo del Oro and Costa Rica's Pre-Columbian Gold Museum regularly send traveling gold-work exhibits to museums around the world. Among the U.S. museums that display their own collections are the American Museum of Natural History and The Brooklyn Museum, both in New York City; the Museum of Fine Arts, Houston; and the Dumbarton Oaks Research Library and Collection in Washington, D.C.

Gold has been mined in Latin America more or less continuously ever since the Waywakas began working those rich placers some 3,500 years ago, and the mining tradition continues today. In 2005, the nations best known for their pre-Columbian gold work—Peru, Ecuador, Colombia, Panama, and Costa Rica—produced nearly 7 million troy ounces (224 tonnes) of gold from both major mines and hundreds of independent placer operations. Now, of course, that gold is shaped into 70-pound bars poured from mill furnaces, a far cry from the magnificent creations of the pre-Columbian goldsmiths.

Shop Talk

William A. Kappele

Enamel Beads

Back in February 1994, I wrote an article for *Rock & Gem* on how to make enamel beads. I'm sure you have seen these little beauties. They are formed by fusing a soft glass to a short section of copper tubing by rolling them in the flame of a torch. I mentioned that I had seen demonstrations on making these beads at shows and had decided to try it myself. In those days, there was really nowhere to go to find out how to make the beads except to the demonstrations at shows or a friend or acquaintance who knew how. Finding the materials was another challenge. All of that has changed, however. The Internet is filled with instructions, instructors, videos, supplies, and even beginners' kits with all of the stuff you need to get started.

In case you haven't run into this part of our hobby yet, these beads are made from a soft glass called enamel. I don't have any idea why glass is called enamel. I grew up thinking of enamel as either something you brushed onto woodwork or something that covered the outside of your teeth. Enamel is a glass formulated to melt at a rather low temperature. It has characteristics of expansion and contraction that closely match those of the metals to which it will be bonded. Enamel comes in a mind-boggling array of colors and, best of all, is inexpensive. The tools needed to get started are also inexpensive and few are required. You will probably already have most of them around your shop.

The main tool is a propane torch, which is available in any hardware store or home center for a few dollars. The least expensive are lighted by a match, a cigarette lighter, or a special torch lighter. For a few dollars more, you can get one with a built-in lighter that works with a press of the finger.

The only other necessary tools are a mandrel to hold the tubing on which the bead is formed and a knife, or something similar, with which to push the finished bead off the mandrel. I'm sure you have a knife, and you can buy the mandrel from one of the suppliers listed at the end of the column, or you can do as I do and use a piece of stainless steel welding rod.

Finally, you will need something to drop the hot bead onto when you finish. The old-timers used an asbestos pad, but we all know what happened to that. I used a small metal pan that I had lying around. It worked all right, but the hot item (no pun intended) today is vermiculite in a hot crock pot. Special fiber blankets, perlite, and lampworking kilns are also used. Just experiment, starting with the cheapest method, until you find what works best for you.

If you have access to the Internet, just Google "making enamel beads" and you will find lots of step-by-step articles with photos of the process. For supplies, books, videos, etc., either of the following will get you started:

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Happy beading!

Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

Kartchner Caverns and the Tucson Show

Natural Beauty Above and Below Ground in Arizona!

Story and Photos by Bob Jones

The great Tucson Gem & Mineral Show will see its 53rd annual incarnation in February. After more than 50 years, it is still ranked as one of the more important gem and mineral shows in the world. The well over 100 really exceptional displays from private collectors and major museums from all over the world make this show a must on everyone's travel calendar.

Less than an hour's drive from Tucson is Kartchner Caverns State Park, one of the world's most beautiful caverns. Located in the Whetstone Mountains about 50 miles east of Tucson, this underground wonderland is just as eye appealing—in its own way—as the Tucson Show.

Like the mineral show, Kartchner Caverns holds wonderful displays of minerals. Of course, these minerals are not as varied, but their graceful form and variety of colorful formations, some of the most spectacular in the world, are well worth a visit. The Tucson Show also has some of the most spectacular minerals in the world.

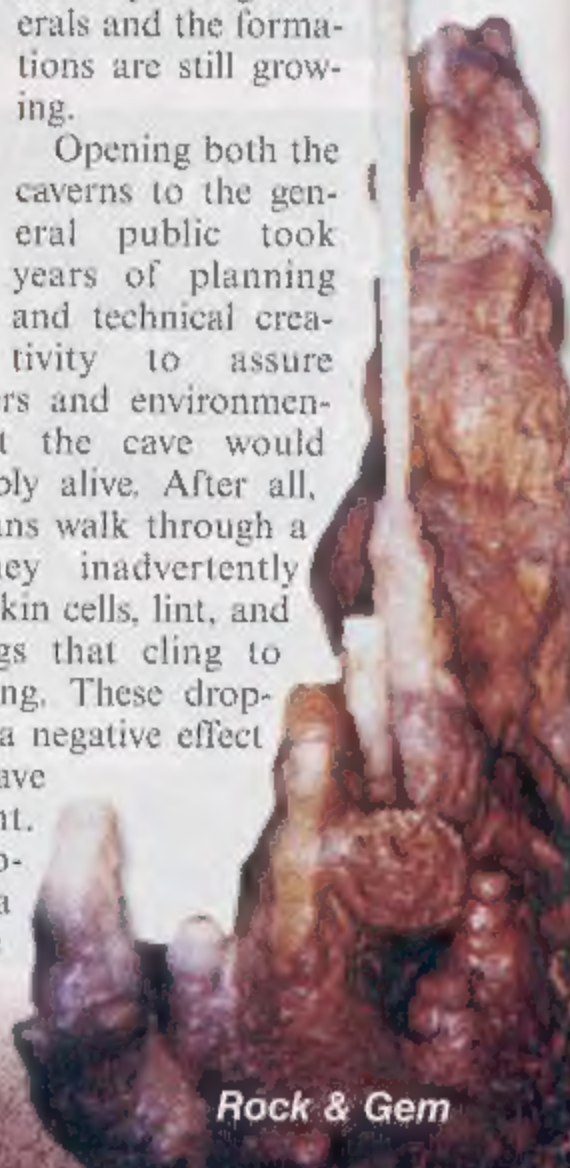
Kartchner Caverns ranks among the top 10 most amazing, most colorful caverns ever created by nature, not only for its great variety of mineral formations, but for the unusual colors some of them exhibit.

As one of the great gem and mineral shows in the world, the Tucson Show always draws a crowd.

While the Tucson Show has been visited by hundreds of thousands of people over its 50 years, Katchner has been visited by tens of thousands of people in a fraction of that time. This is because it was unknown to humans until 1974. In that year, it was discovered by two spelunkers, but it was kept secret and wasn't open to the public until 1999—and then only partially so.

Kartchner consists of two adjoining caverns. The "throne room" was opened first. It took a couple years more to open the second, larger cavern. The main reason it took so long is because it is a living cave, and preserving that condition required a vast amount of study, research and investment. In living caves, water is still depositing minerals and the formations are still growing.

Opening both the caverns to the general public took years of planning and technical creativity to assure nature lovers and environmentalists that the cave would remain viably alive. After all, when humans walk through a cavern, they inadvertently drop hair, skin cells, lint, and other things that cling to their clothing. These droppings have a negative effect on the cave environment. Worse, people have a strong urge



The bases of these formations are colored brown by deposits of bat guano that are up to 40,000 years old.

to touch, even caress, nearby formations. The temptation to break off formations—a practice forbidden in Kartchner—is great. Opening the caverns to foot traffic and still preserving them for future generations took a great deal of study and planning.

For instance, when concrete walkways and structures were poured underground, every ounce of concrete was carried into the cavern by hand. No power machinery was ever used inside the caverns in order to preserve the delicate atmosphere. A worker who inadvertently broke a stalactite was fired on the spot! Any human touch can inhibit the growth of a stalactite, so workers were especially protective of this fantasyland.

You may wonder why I'm discussing two major tourist attractions—the Tucson Gem & Mineral Show and Kartchner Caverns—in one article. That they are tourist attractions is reason enough. Their close proximity to each other is another good reason. It's a natural thing for these two entities to work in concert during the four days of the Tucson Show, and they do.

One of the important features of the Tucson Show is the Galleria, the vast

Tucson always has displays of fine minerals, such as these Tasmanian crocoites from the Albert Chapman collection.

This part of the Kartchner Caverns is called the "Strawberry Room" because of its rich red formations.

hallway leading from the main entrance. The Galleria is perfectly suited to be lined with booths offering all sorts of educational and useful things. The Tucson Gem & Mineral Society offers these spaces free of charge to any government agency or nonprofit group that offers free materials pertaining to Mother Earth. Groups with space in the Galleria include the U.S. Geological Survey and, appropriately, Arizona State Parks and Kartchner Caverns.

The Arizona Parks booth is manned by volunteer park personnel and volunteers from a group I have worked with for years, Friends of Kartchner Caverns State Park. This organization has done trojan work to promote educational endeavors for the caverns, including fundraising for activities the state either can't or won't finance. Even before the first cavern opened, the Friends were able to work through the Tucson Gem & Mineral Society to raise thousands of dollars.

When you visit the Tucson Show, you can obtain information not only about the state park system, but about Kartchner Caverns specifically. Even more exciting, you can actually set up reservations for a cave visit while at the Tucson Show.

This is possible because the Friends set aside blocks of tour reservations that can only be obtained at the Tucson Show. Interested show visitors can visit the caverns on the Monday or Tuesday immediately after the show, which closes on Sunday. Since reservations are really tough to get during the winter tourist season, being able to make reservations at the show is a great opportunity.

Because of the popularity and importance of the Tucson Gem & Mineral Show, dozens of other shows have evolved and take place during the same general time period. There are retail and wholesale shows emphasizing gems, minerals and fossils, all of them worth a careful look. Because of all the shows—there are more than 40 of them now—many visitors stay in Tucson for two or three weeks.

Surely, many of these people get "mineraled out," so to speak. After days of tramping from one show to another and going in and out of motel rooms, they all begin to look alike. The time you spend searching for parking and, worse, the time spent waiting for a good meal only adds to your stress.

It has struck me that one delightful way to relieve the stress for a day—and sometimes the boredom your noncollecting family members experience—is to leave town. Why not get down to Kartchner Caverns and enjoy a stunning visit to one of the top 10 limestone caverns in the world?

If you plan to visit the caverns before, during or after the Tucson Show, you can call (520) 586-CAVE or visit www.pr.state.az.us/Parks/parkhtml/kartchner.html to make reservations.

Kartchner Caverns can be reached easily from Tucson. Just head east on Interstate 10. It is less than 50 miles to Exit 302, which is well marked for the caverns. Take state Route 90 south nine

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Kartchner Caverns and the Tucson Show *from page 21*

miles and you drive into a nicely kept state park with campgrounds, a Visitor's Center, hummingbird area, and picnic area. There is also the most amazing complex of underground limestone caverns you'll ever visit.

What I find almost hard to believe is that the caverns are no more than a few dozen feet below ground. Mr. Kartchner, the rancher who owned the land on which the caverns were discovered, used to comment while riding over the Whetstone foothills that the mountain sounded hollow. And indeed it was!

If you read my book on the 50-year history of the Tucson Show, you know the show started quietly enough in a school cafeteria. It didn't take long for it to move into the circle of "must-see" shows. The main reason the show became so important was that it adopted the practice of inviting universities and major museums to display their best natural minerals and cut gems.

The first major museum to be invited to the Tucson Show was the Smithsonian Institution. In 1961, curator Paul Desautels brought two choice displays and gave two excellent talks on minerals and gems. Since that time, Tucson has become one of the world's best places to see and buy gems and minerals these last 50 years.

With the growth of what locals call satellite shows, Tucson really does cater to every facet of the world gem and mineral market.

While Tucson has been ongoing for more than 50 years, Kartchner Caverns has only been known publicly since the 1990s. Though discovered in 1974, it was kept relatively secret for 14 years. The original discoverers, Randy Tufts and Gary Tenen, shared their secret with the owners of the ranch on which the caverns are located. That was necessary, since the guys hoped the ranch owners would consider selling that portion of their property so the caverns could be properly protected and developed.

Gary and Randy also shared the caverns with certain strategically positioned people in business and government, who could help fund the purchase. Unlike the Tucson shows, where everyone is doing their best to display their wares, Gary and Randy didn't want people to see their find until it was secure. Vandalism is a horrible problem in unguarded caves.

One thing I learned while working with spelunkers (folks who explore caverns) is that they don't think much of mineral folks. They feel some of us damage or remove cave formations when we can. Whether this is true or not, the mineral collecting world has a PR problem, not only with spelunkers, but with mine owners. Maybe some PR could be done at shows like those in Tucson! I know the Tucson Show group does its best already.

Tucson dealers sell everything from fine mineral specimens to jewelry.

The 2007 Tucson Gem & Mineral Show will feature Australian minerals and gems. Opal will be in good supply, of course. You can count on the Australian museums that have been invited to display opal, along with great gold specimens and choice specimens from some of Australia's famous mines like Broken Hill, New South Wales.

American and European museums will add an array of fine Australian minerals to the Tucson Show displays. Private collectors will do their best to outpace the museums with displays of amazing gem crystals and rare species in unheard of sizes and quality. I've enjoyed being involved with the Tucson Show for more than 40 years and am always pleasantly surprised with what is up for sale and on display! I first attended in 1959, just four years after it got going. In every one of those years, the show never failed to amaze me.

I might say the same for every visit I've made to Kartchner Caverns, though I've only been underground there about four or five times. I was even lucky enough, as a member of the Friends of Kartchner Caverns Board of Governors, to enter each cavern during its construction phase. We were allowed to take photos of the formations, something not allowed now that the caverns are a functioning state park.

Each time I went underground, I was amazed by what I saw. The variety of cave formations, the lively colors of many of them, and the breathtaking views I saw at every turn made me realize how skillful Mother Nature really is.

The story of Kartchner Caverns is fascinating. Gary and Randy, trained spelunkers, decided to check out a small sinkhole located on the eastern slopes of the Whetstone Mountains. It was just large enough for two guys to climb into.

The Whetstones consist of a series of formations ranging in age from Precambrian to recent. Part of this complex is a huge block of Escabrosa limestone that sits rather isolated in the area. The same limestone formation outcrops separately farther south at Tombstone and Bisbee.

When Gary and Randy climbed into the small sinkhole, which is still there next to the trail leading to the new entrance tunnel, they could smell bat guano. This may not seem remarkable, but it was only possible due to the timing of their visit.

Some caves "breathe in" and "breathe out" under certain atmospheric conditions. During periods of high atmospheric pressure, outside air surges into a cave opening (breathing in). During times of low atmospheric pressure, air flows out of the cave (breathing out). It so happened our two doughty explorers were in that sinkhole during a period of low atmospheric pressure. The outgoing airflow brought the smell of bat guano with it, a good sign that they were on to something.

These two curious fellows hammered out the small opening enough to squeeze through and found themselves in a long, narrow tube. They crawled along this rock tube, which was so small they had to extend one arm so as to narrow their shoulders and could only push forward with their toes. There was no way to turn back if they hit a blockage or the tube narrowed down. They had no idea how far this tube extended or where it ended.

As it turned out, the tube was well over 100 yards long! As Gary and Randy went deeper into the tube, the bat odor got stronger. This encouraged them. Finally, the narrow passage opened up into a huge room now called the Big Room. Before them was an amazing array of cave formations completely decorating a huge cavern. Several places were piled high with bat guano, which suggested bats had used the cave for centuries. Studies later estimated their presence at 40,000 to 50,000 years!

During the secretive 14 years, Gary and Randy explored the cavern, being very careful to touch things only when necessary. They marked their trails so they always walked in the same places. They never tried to touch the formations. After several years of silence and exploration, they approached a couple of environmental groups about developing the cavern, but were turned down. When I was on the board of the Arizona Sonora Desert Museum, I was asked to bring the idea before the board to see if they were interested in being involved. I was told not to accept.

In the meantime, Gary and Randy decided to approach the owners of the ranch on which the cavern was located. Their plan was to get the state of Arizona involved in obtaining the land and turning the place into a state park. So, four years after the initial discovery, the Kartchner family was informed they had a treasure underfoot. Gary and Randy guided a couple of family members in to the cavern so they could see what was there and appreciate the need for secrecy. They obliged. Then the governor of Arizona was informed of this new underground treasure that had to be preserved. Like any curious person, the governor decided he needed to see the place for himself before committing funds.

Bringing the governor underground created a problem. His health was not perfect and the guys realized if the governor were to crawl into the cavern and then become ill, there was no way medical aid could get to him. They decided to create another access to accommodate special visitors.

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Kartchner Caverns and the Tucson Show *from page 23*

Young collectors can get a free collection of representative minerals at the Main Show in Tucson.

After years of secret talks with the appropriate legislators, a bill was quietly introduced into the state legislature that would provide funds to purchase the land in question. Again, there was problem. As soon as any bill was introduced to committee, the existence of the cavern would become public knowledge. To preserve the secret, a little trickery had to be employed.

A dummy bill was assigned a number and put through the usual committees in both houses. It apparently didn't say much, but the right people in the legislature knew of the plan and the real purpose of the bill, so they saw to it that the bill sailed through committees. On the last day of the legislative session, the real bill, with the same bill number, was substituted for the dummy and passed. I suspect most legislators didn't know they had voted to spend millions of dollars on a hole in the ground!

Can you imagine what would have happened if legislators had all known of the cavern? Visualize dozens of tubby legislators insisting on crawling into the cave in before approving a dime for the project. As funny as that would have been to see, it would have messed things up. Before Kartchner Caverns was ready to be opened to the public, the project cost some $30 million.

During their years of quiet exploration, Gary and Randy explored every corner and formation in what became known as the Big Room. Eventually, they were surprised to find a second small opening that beckoned to be explored. This opening led into yet another huge cavern system, another natural wonderland of stalactites and stalagmites. This cavern contains the Rotunda and the Throne Room.

Today, the Big Room and the Rotunda/Throne Room are separate tours the public can enjoy. The Throne Room tour opened first. It required less technical work and lent itself to easier development. The Rotunda/Throne Room tour is open year-round.

The Big Room offers a longer tour. It is my favorite, but it's closed during the summer. From April to October, the Big Room becomes a bat nursery!

It is known that the bats are visitors from Mexico, but we don't know how they found the cavern. The opening the bats once used no longer exists, probably sealed by ground movement or limestone collapse. They then found the same small opening that gave Randy and Gary access to the Big Room. About 1,800 female Mexican bats head into Arizona every year to give birth to their pups.

What better place to give birth and train the bat youngsters to fly than where the sun never shines? In the peace and darkness of the Big Room, the female bats congregate and stay through the heat of the summer. The bat pups eventually learn to fly in the darkness of the cavern and follow their mothers to Mexico come April. The Big Room is closed completely during the summer so as not to disturb the little mammals.

Luckily for tourists, the bats don't show up at Kartchner until six weeks to two months after the Tucson Show closes. Whether you visit Tucson before the show or plan to stay a few days after the show, both cave tours are open and ready for your visit.

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Kartchner Caverns and the Tucson Show *from page 24*

What will you see when you visit the caverns? They have the usual stalactites and stalagmites, and some most unusual ones. There are dozens of columns, calcite shafts that form when a stalactite and a stalagmite meet and grow together.

There are hundreds of caverns in this country and around the world. What is so special about Kartchner? Why is it ranked among the top 10 most beautiful in the entire world? Would you believe yellow, orange and red stalactites? Not all the formations are brightly colored, but enough of them are stained by iron oxide or manganese oxide to make a more interesting cave visit. These metal oxides are brought into the caverns dissolved in the rain water that keeps the cavern alive.

There are other, more familiar formations to see, as well. Ribbons of bacon calcite hang from ceilings. Crazy, twisting helictites randomly jut from the walls and ceiling. Perhaps most interesting are the long, slender, white, tubelike growths hanging from the ceiling. These represent the birthing of more stalactites.

They begin as tubes formed by calcite-rich water trickling from the ceiling. The water trickles down the inside of the tubes. At the tip of the tube, the water evaporates, depositing a few molecules of calcite. This action builds a long, thin tube. Since the water also carries bits of clay with it, the tube often gets plugged. Then the mineral-rich water trickles down the outside of the tube, forming layer upon layer of calcite.

Once in a great while, the tubes don't plug up but continue to grow. They are exceedingly delicate and often break off. In Kartchner, many such straw growths – we call them soda straws – formed. The largest soda straw in Kartchner Caverns exceeds 21 feet in length. It is the world's longest. Studies have shown this marvel of calcite growth took 16,256 years to reach its full length.

Then there are the odd formations, mineral patterns on the walls created when water deposits calcite in cracks behind chunks of limestone already heavy with stalactites. Eventually, these limestone blocks tore loose, leaving shield-like shapes where they used to be.

In one section of the ceiling in the Big Room are really odd, bulbous stalactites that look like the bottom end of turnips, something only a gopher would see as he tunnels through a garden.

Probably the most unusual mineral formation, aside from the organic species that have formed in bat guano, is a white flow of calcium hydrogen phosphate, a rare mineral known as brushite. The brushite in Kartchner is the largest single deposit known in the world.

The Rotunda/Throne Room tour holds its own pleasures. Central to it all is Kubla Khan, the largest stalagmite in Arizona at 58 feet high. This cavern features a light show designed to spotlight different types of formations as pleasant mood music makes you forget the real world not far over your head.

When you visit the caverns, you'll be comfortable with a light jacket as the temperature is 68 degrees. The humidity is very high since the Cavern is still "alive," with formations still growing, albeit slowly.

The costs of the tours vary. The Rotunda Room tour is $18.95, while the Big Room tour costs $22.95. The parking fee is waived if you have a reservation. Camping costs $22. The park is only closed on Christmas Day.

The 2007 Tucson Gem & Mineral Show is a four-day affair beginning on Feb. 8, 2007. It opens each day at 10 a.m. and closes at 6 p.m., 5 p.m. on Sunday.

The Tucson Show actually starts on Wednesday, Feb. 7, which is set up day. That's when the marvelous exhibits are installed, including the huge skeleton of Stan-t-rex, one of the more complete Tyrannosaurus rex skeletons. He comes to the show from the Black Hills Institute, world famous for its amazing dinosaur discoveries and excavations.

On Wednesday evening, the TGMS puts on its reception. The 6:30 p.m. reception is the annual kick-off event of the show. This has become a tradition in Tucson and is always a great social evening.

You do not want to miss the reception this year because the featured speaker is one of Australia's better known authors and opal experts, Len Cram. Len has written some great books on Australia's opal fields and the gems that have been found there. If you love this fiery gem, you have to plan on an evening with Len, who will lecture on "Australian Opal and Its History." You will not regret it!

Attending the Tucson Gem & Mineral Show gives you a dual reason for being in Arizona. You can enjoy one of the great shows of the world and, with a little extra time, visit one of the great caverns of the world! See you there!

The Frugal Collector

The Silicates

Part V: Lapis, Charoite and Sugilite Are Popular with the Lapidary

Story and Photos by Bob Jones

The vast majority of silicates we collect are crystallized minerals. With quartz leading the crystal parade, the collector silicates are the core of almost any collection.

Within the silicate class of minerals there is also a small group of noncrystalline, solid, colorful, and sometimes inexpensive massive minerals that is very popular with amateur lapidaries. Such silicates, once treated by the lapidary, can be very valuable and attractive in a crystal display because of their vibrant colors and usual internal patterns and features.

Silicates form the great majority of what we call semiprecious gems. They include agate, petrified wood, lapis, charoite, gem silica, and a clutch of quartz varieties, which dominate the semiprecious silicate gem group. These opaque to translucent silicate minerals tend to be much less costly than the transparent crystallized silicate gems like topaz, elbaite, and the beryl varieties.

Ask any amateur lapidary to name a favorite cutting material and chances are it will be a massive silicate. Quartz, for example, occurs as chrysoprase, fire agate, gem silica, petrified wood, and a host of other agate varieties.

Beyond the quartzes, the colorful, superb, massive gem minerals worthy of our attention include the silicates sugilite, zoisite, charoite, chrysocolla and lazurite (lapis lazuli). Of these, lazurite occurs as discrete crystals, but its greatest use in lapidary is as a massive bright-blue gem.

The gem silicate lapis lazuli has been known for thousands of years and was among the earliest gemstones to be mined. The colorful newcomers charoite and sugilite have only been on the lapidary scene for decades, not centuries. Mother Earth still has secrets to be discovered, and among those secrets may be other attractive massive gem minerals.

GEMS MUSEUM MOSCOW

Charoite is now fashioned into a great variety of useful and decorative objects

As the value of minerals rises and the demand increases, the search for gem minerals in more remote places will continue to accelerate. Think of nambuite, the new cutting material from Australia. Think of China and Russia, two vast lands that have not yet been fully explored. And surely Africa has not been completely revealed to us as yet.

As soon as we begin a discussion on lazurite, we run into an identification problem. That's because there are two minerals whose names can be easily confused, lazurite and lazulite. Both names come from the Persian root *azhuard*, which means "blue."

Lazulite, the collector mineral, is a hydrous magnesium aluminum phosphate and does not belong in this silicate discussion. Lazurite, on the other hand, is a very complex hydrous sodium, calcium aluminum silicate with sulfur and chlorine in its structure. Lazurite is the dominant mineral in lapis lazuli, usually referred to simply as lapis.

Lapis is not a single mineral. It is a far more complex mixture—actually a rock by definition. This wasn't even figured out until the 1800s. The classification of "rock" doesn't mean anything to an artist bent on creating a lovely gemstone carving or piece of jewelry. It's the color that counts!

The dominant mineral, lazulite, does not act alone. Just as important to the color of lapis are the minerals sodalite, a silicate, and hauyne (AH-ween), a sodium, aluminum, calcium, silicate sulfate. Lapis also contains calcite, which appears as small white spots or streaks in the blue groundmass.

The entrance to the altar of St. Isaac's Cathedral is bracketed by 30-foot-high columns of Siberian lapis.

GEMS MUSEUM MOSCOW

Sprays of charoite needle crystals in a setting of other minerals give the material a chatoyant look.

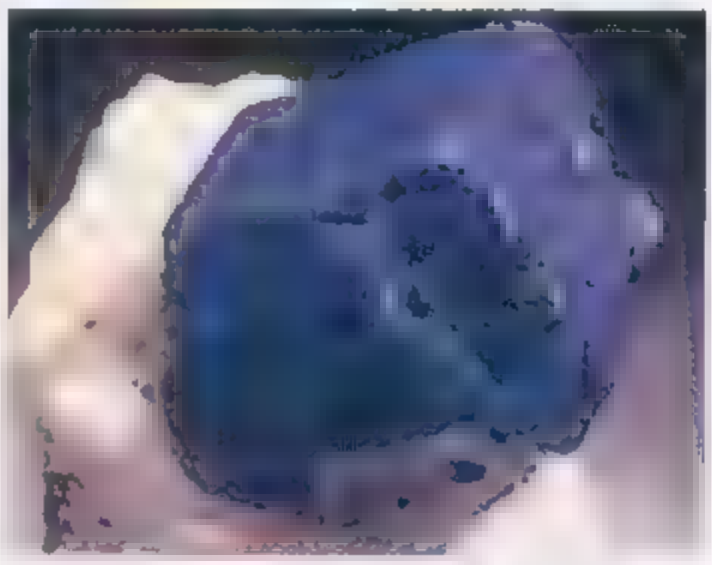
While these minerals are very important in the formation of lapis, in my opinion, the key mineral is pyrite. It is always present in lapis and was one way to distinguish between natural and synthetic lapis until scientists figured out how to introduce pyrite into the synthesis.

Other minerals that are found in lapis are nosélite, a sodium aluminum sulfate silicate, and feldspar, another silicate. These minor minerals, along with the calcite, account for the white spots you often see in lapis.

Lapis is categorized by scientists as feldspathoid. That means that, had enough silica quartz been present when the mineral formed, it would have become a feldspar. We're glad it didn't!

Lapis is a product of metamorphism, having formed as a result of extreme heat and pressure along the contact between limestone and other older rocks. It has been used as a gemstone for at least 6,000 years. Lapis has always been rare because it occurs sporadically and is so difficult to mine due to its remote occurrence. The area in which it is best found is located among the roadless, steep valleys and rugged terrain of the high mountains of Afghanistan. Other lapis occurrences hold minor amounts of less vibrantly colored material.

Because of its scarcity, only kings and royalty could afford lapis in ancient times. The Babylonians used it as a royal carving material. Thousands of interesting lapis carvings were unearthed during archeological excavations of royal residences at the City of Ur in what is now Iraq. Egyptian pharaohs used it in their ornamentation. Their royal ladies crushed it for blue eye shadow.



Afghan lapis gets its color from the mineral lazulite, seen here as a lovely dodecahedral crystal.

Lapis ranks with turquoise as one of the oldest gems ever mined. It is surprising that the deposit that produced this lovely blue gem for the Egyptians and Babylonians and tantalized Marco Polo in 1271 was even found at all. More remarkable, the mines are still producing massive cutting material and crystal specimens today!

There is no record of when lapis was first found and worked, but whoever found the deposit along the Kochka River high on a cliff overlooking a deep river valley was one brave soul. Even today the challenge of mining the remote and dangerous deposit has kept the supply of this lovely gem rather limited. Luckily, more lapis is being mined than ever before and much more attention is being paid to preserving the lovely dodecahedral crystals of lazulite that are occasionally found in this deposit of mostly massive lapis.

Currently, the blue gem is coming from the Sar-e-Sang Mine, one of the Furgamal mining region deposits in the Badakshan region of Afghanistan. The crystals and massive veins occur in white calcite marble.

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The old fire-and-water method was used in the early days to loosen the blue stone, a method that undoubtedly destroyed more crystals than it revealed. A fire would be built to heat a rock face, then cold water would be dashed against the hot rock. The resultant rapid cooling cracked the rock, making it possible to pry chunks loose to recover the lapis within. Today, mining is done with explosives, but more care is given to saving crystals. Once a crystal is exposed, the white rock is carefully excised around it to make an attractive specimen.

Crystals of lapis, the gem variety of the mineral lazurite, form in the cubic system. Haüyne and sodalite, both integral parts of the lapis, are also cubic. Crystals, however, never show a simple cube form. Instead, lapis crystals are always 12-sided dodecahedrons. At best, a crystal may be well over an inch, seldom reaching 2 inches across. Rarely, a penetration twin shows up.

The massive blue material from the Sar-e Sang Mine is used by artists to create all sorts of carvings, objets d'art, and jewelry stones. Lapis beads have been consistently popular through the ages. Afghanistan is the most important source of lapis display crystals.

Russia can boast a premier source of deep blue lapis, though you seldom see any foreign from this remote deposit. Fine, deep blue lapis, both massive and in well crystallized dodecahedrons to an inch, is found in the Sayan Mountains, along the Slyudyanka River south of Lake Baikal in Siberia. This deposit provided huge pieces of fine material for the gem carvers of the czar's lapidary factory in Ekaterinburg.

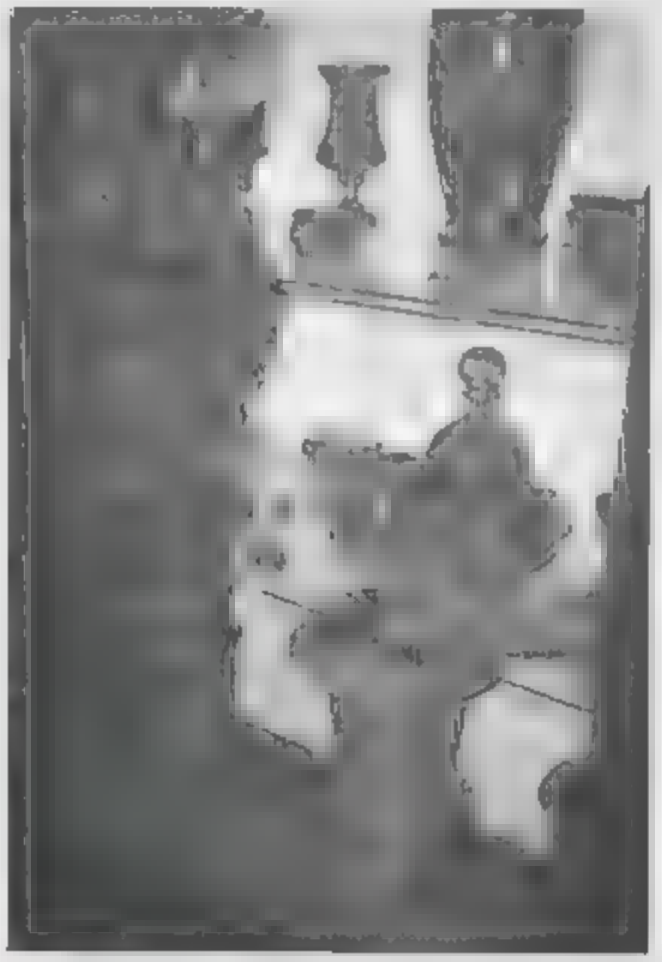
The finest examples of this work can be seen in the Hermitage in St. Petersburg. Superb, deep blue tazzas (shallow bowls on pedestals) measuring 3 and 4 feet in diameter were carved from multiton pieces of lapis. The carved bowls stand on a fluted stem of lapis about 4 feet high.

The Russian artists also used lapis to make solid-appearing mosaic structures. Tables, desks, vases, and even small boxes were shaped in some inexpensive rock like limestone or basalt, then veneered with thin slices of lapis. One stunning example of lapis mosaic can be seen in St. Isaac's Cathedral in St. Petersburg.

Separating the nave of the church from the altar is a broad, solid wall consisting of panels picturing the patron saints of Russia. Each figure is not painted, but done in gem intarsia. Separating these panels are 10 50-foot-high columns done in malachite mosaic.

In the center of that wall is the entrance to the altar flanked by lapis columns, each standing 30 feet high! All these columns are copper cylinders that have been veneered with superb green malachite and deep blue lapis from the Lake Baikal deposit. They are truly an impressive sight!

In the United States, there are a couple of significant lapis localities, but neither is producing anything of note now. Ontario Peak, in the San Gabriel Mountains of



The GEMS Museum in Moscow has a great variety of objets d'art using multipatterned charoite.

California, was an occurrence of good blue lapis. A fellow named Sam Sperstra found this deposit and mined it out.

Sam's life is one of great fascination. I met him when we were doing a Smithsonian video called "Gemstones of America." He was running a sapphire recovery operation along an ancient gravel bed of the Missouri River at the time. In the past, Sam had discovered a ruby deposit in India while doing religious studies. Being a friend of Beatles musician George Harrison, he asked for a loan to develop the property and George obliged. Most of the rubies Sam found were not gem quality, but were very nice, deep red, hexagonal crystals and were marketable. To pay back the loan, Sam shipped George a huge quantity of loose ruby crystals and George embedded them in a new pool deck he was building!

Another nice U.S. source of lapis was found in 1939 high on the slopes of Italian Mountain in Colorado's Sawatch Mountains. This deposit is under claim and is intermittently worked now. The lapis tends to be found in thin stringers, often of light blue color.

There is another low-grade variety of lapis being sold, a form that is now quite popular. In Afghanistan and Chile, lapis often occurs as a pale blue rock with a fairly high white calcite content. Though lacking the intense blue color of the best lapis, this material sells nicely now, thanks to Mahbob Azizi, who owns Liberty Gems and Minerals in Albuquerque, New Mexico.

Mr. Azizi had the brilliant idea of calling this pale blue and white mix "denim" lapis. The color effect was the result of small, pale blue grains of lapis mixed with small grains of white calcite. Under its new name, sales of the material took off. What used to be considered low-grade rock now has a recognized place in the gem industry.

Sodalite, a mineral that is often an integral part of lapis, is a very attractive silicate gem material on its own. Sodalite is a sodium aluminum silicate with chlorine. It is a cubic mineral, as is lazulite, the other blue mineral in lapis.

Sodalite occurs in nepheline syenite rock types, which resemble large-grained pegmatites but are lacking in quartz. In the Princess Quarry at Dungannon, Ontario, Canada, blue massive sodalite occurs, but creamy white massive sodalite is more frequently found. Sodalite occurs at Mont Saint-Hilaire, Quebec, in crystals, one of the few places in which discrete crystals of this mineral are found. Much more often, it occurs as a massive material in Greenland, in Russia, and in Ice River, British Columbia.

The most remarkable occurrence of sodalite is as a variety called hackmanite, a name no longer recognized in the literature. Sodalite to acquired this odd name because in some occurrences, such as at the Davis Hill Mine in Bancroft, Haskings County, Ontario, the mineral shows tenebrescence. Tenebrescence describes the property of changing color in response to light energy.

The sodalite (a.k.a. hackmanite) from Bancroft is normally a creamy white color. When it is exposed to strong ultraviolet light, it takes on a pink to peach to red-violet color, sometimes with an extremely strong response.

As if this color change is not unusual enough, the color will fade away when the specimen is put in sunlight. Hidden in a drawer, however, it will hold that color for a long time. The rate of color loss is more or less related to the intensity of the light. Put the piece back under the long-wave UV light, and the lovely violet-red color comes right back. This capability to change color repeatedly is called reversible photosensitivity.

Those who specialize in collecting fluorescent minerals, as I did in my early

years, find hackmanite particularly exciting to own. When I was collecting such things, I was able to go along the York River and the Davis Hill area to collect bits of this mineral. That is no longer the case.

It's only natural to want to know what causes such an odd reaction to ultraviolet radiation. It is due to the presence of a trace chromophore, sulfur, in the structure of the sodalite. The blue color in lapis is also due to sulfur's electron movement; these electrons absorb color energy.

While lapis ranks as one of the oldest gemstones ever mined, we are fortunate to have seen the appearance of two new superb lapidary gem materials in recent decades: charoite from Siberia and sugilite from South Africa. Both were discovered less than 50 years ago and now are an integral part of the gem silicate scene. That both are a superb royal violet color makes them all the more exciting in my opinion. Imagine, if you will, what some of the Russian palaces, now museums, would look like had the violet gemstone charoite been known to the Russian czars several hundred years ago. It would have joined rhodonite, malachite, lapis, and the wide range of colorful agates in decorating these Russian structures.

On one of my visits to St. Petersburg, I met mineralogist Vera Rogova, who first analyzed and described charoite. She was most gracious in describing her discovery of and research into this new gemstone.

Charoite is not named for the Chara River, as most reports suggest. Its name is based on the Russian word "chary," meaning "magic" or "charmed," and charmed it is.

Like lapis, charoite is a mixed breed, a rock that is composed of 13 different minerals, with the mineral charoite dominating to give the rock its bright violet color. Charoite itself is a very complex mineral, a hydrous hydrate of sodium, potassium, calcium, fluorine silicate. It was initially formed as a potassium feldspar at the contact of limestone and quartz poor nepheline deep in the Earth. But due to a secondary process, the feldspar was altered and charoite is the result. In this process, called metasomatism, the invasion of late-stage hydrothermal solutions alters the existing minerals.

The exact location of the Siberian charoite deposits—and there are at least 25 known outcrops in the area—is in what is called the Murun Massive, a very ancient, complex series of crustal rock formations located northeast of Lake Baikal. The Murun Massive formed deep in the Earth and was brought to the surface by crustal movement and erosion.

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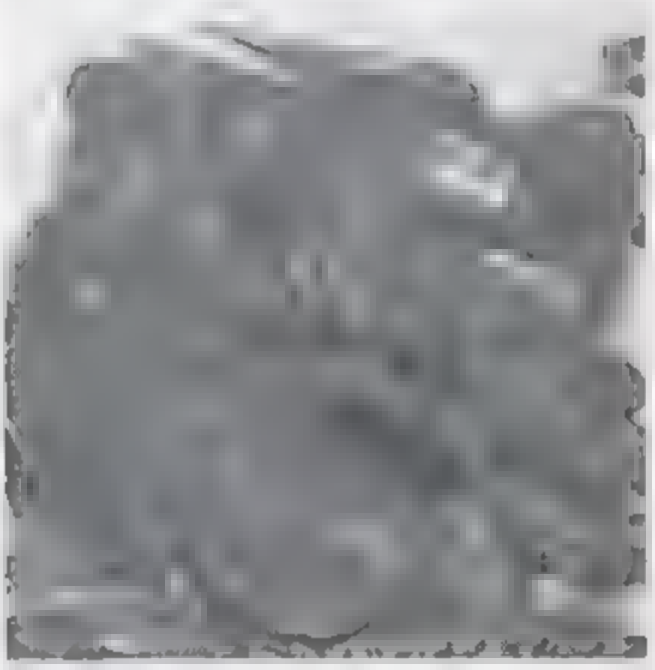


This massive piece of Siberian lapis has been carved into a lovely objet d art

It takes several days' overland journey to reach the charoite deposits, which explains in part the high cost of the material. When we were planning to do a second video on Russian gemstones, the charoite area was one target for us. The plan was to helicopter near the site and hike in. I even had my fishing hat equipped with an insect net, ready to go. Unfortunately, government finances took a turn for the worst and those plans are still on hold.

In spite of the remoteness of the deposit, tons of this superb gemstone have been mined and reached the gem market. The initial loads ended up in London, where buyers immediately snapped up the better material.

Charoite is a homogeneous mass that occurs in relatively small sections within the overall rock face. Thus, charoite is actually a rock with a multipatterned look due, at least in part, to the other minerals of various colors and forms with which it is intimately associated. Even charoite itself comes in a variety of forms and habits. The result of all this intermixing is a multicolored, variegated rock of beautiful patterns, exceedingly colorful and attractive.

The variety of minerals included in charoite range in color from black to orange, and every piece seems to hold a surprise for the lapidary with every cut. Some of the charoite has a distinct, lustrous, silky look, while other pieces are heavily mottled with swirling, curving, patchy or streaky patterns. In fact, the pattern seen in any particular piece is subject to interpretation by the viewer. This is because the many variations of the charoite combine with the patterns of the several dominant minerals with which it is associated. As the light strikes the surface of the charoite it reflects a sheen, or a chatoyance, that varies as you rotate the piece.

The major minerals included in charoite are canasite, tinaksite, quartz, aegerine, ekanite and fedorite. There are other, less notable species, as well. Most of these associated species were identified by Vera Rogova. Not surprisingly, as new minerals emerged during the studies, some of the credit for her discovery was given to the head of Vera's research group.

As for what causes the colors in the rock, manganese is the chromophore in charoite, but the mineral can be any shade of violet, grayish lilac, brownish red, tan and even gray-brown. Iron undoubtedly acts as a chromophore, as well. A complete list of chromophores that may cause color in the minerals of charoite rock has yet to be developed by research.

When this material was first seen around 1949, it was called lilac cummingtonite, which is a relatively unimportant hydrous magnesium silicate. Little work was done on the material until Vera visited the area in the 1950s. She immediately realized the potential for new minerals at the site and began researching the composition of this attractive rock. By 1974, she was able to announce her discoveries.

At first, the rock was called canasite, after the other dominant species. But continued study showed that charoite was even more dominant in the rock and provided the lovely violet color.

The series of deposits in which this lovely lapidary silicate is found is along two small streams, the Dimar and Davan, which are part of the Chara and Olekma rivers in Yakutia, Siberia. The site is reached largely by boat, with a short overland trek to finally reach the outcrops. Again, this tends to limit the supply and goes far in explaining the cost of what we have in hand.

Doing lapidary work with charoite is a decided challenge. Its mix of 13 minerals really creates difficulties with undercutting when you run your diamond belt across charoite. The various hardnesses and splintery habits of some of the species require an understanding of the material. For example, ekanite, a fairly common species in the rock, has a hardness of Mohs 4.5, while quartz, which occurs in small amounts throughout the rock, has a hardness of Mohs 7. Such distinct differences in hardness require skill to avoid undercutting.

Then comes the challenge of achieving a good polish on a surface of varying hardnesses! Still, charoite does polish to a fine, smooth, lustrous finish. I've seen some absolutely magnificent finished charoite, so a skilled lapidary is certainly capable of bringing out the best of this relatively new violet-hued rock.

ROADSIDE PANNING SITES IN NEW MEXICO

Part I: Bernallilo, Catron, Colfax, Dona Ana, Grant, Lincoln, Luna and McKinley Counties

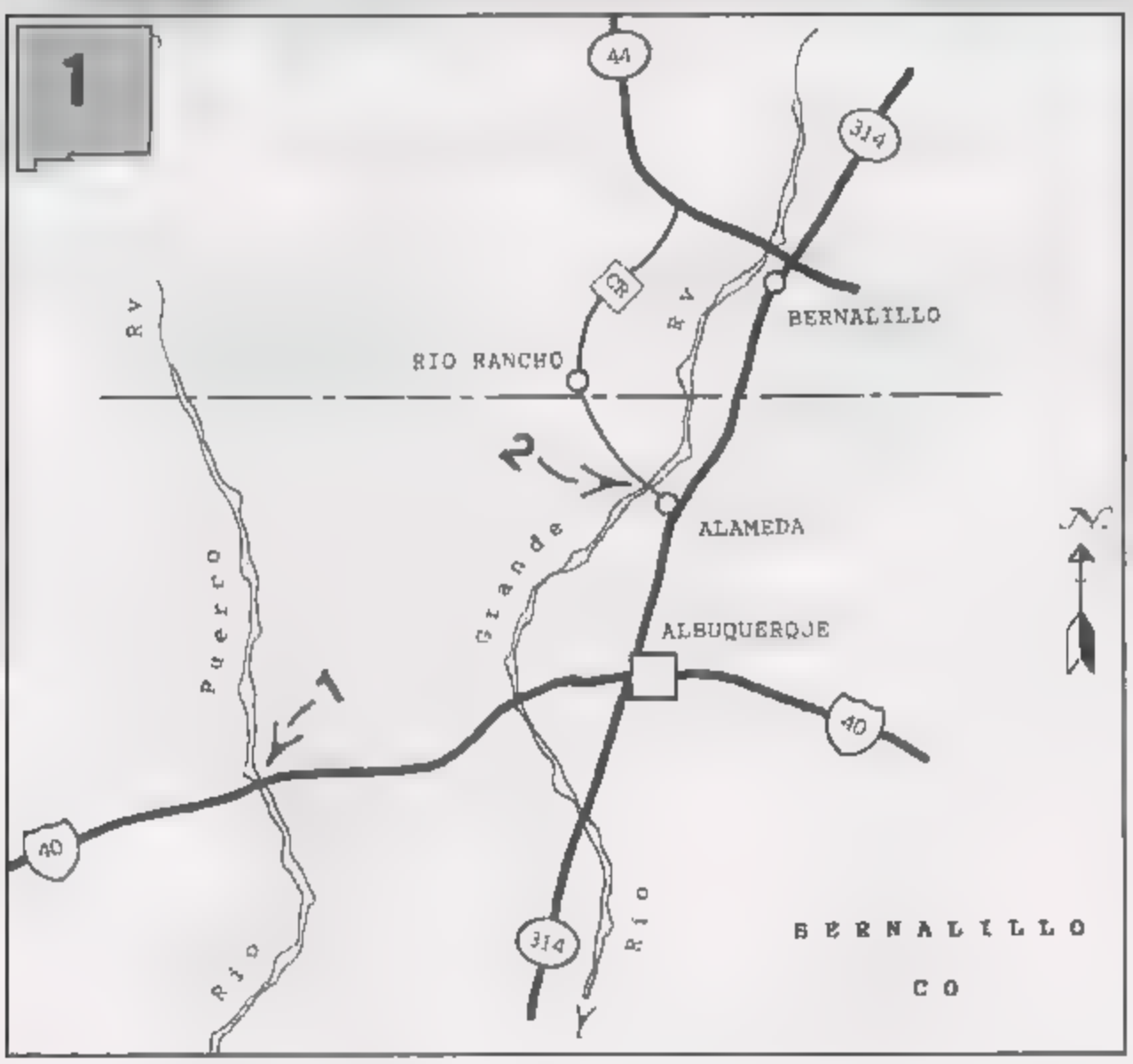
Story and Maps
by David and Clois Walker

This is the first in a series of two articles containing maps that indicate suggested panning and screening sites at New Mexico highway stream crossings where appreciable finds have been previously reported in vicinity watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan. This is a speculative study; whether conditions at these sites are conducive to panning activities and whether minerals can indeed be found have not been investigated.

By confining operations within government-purchased highway rights of way, panners are spared the necessity of locating and obtaining permission from adjoining property owners, including state and national parks and Indian reservations. However, readers run the risk of prosecution if they cross onto private land, whether purposely or inadvertently. In instances where rights of way have merely been leased, other rules may apply.

Remember that the government to which these rights of way belong has some regulations of its own. Observe highway safety and environmental standards, such as parking only where designated, and using only a pan and scoop.

The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway or county map when planning an outing, for overall orientation in the field and because highway designations have been known to change.



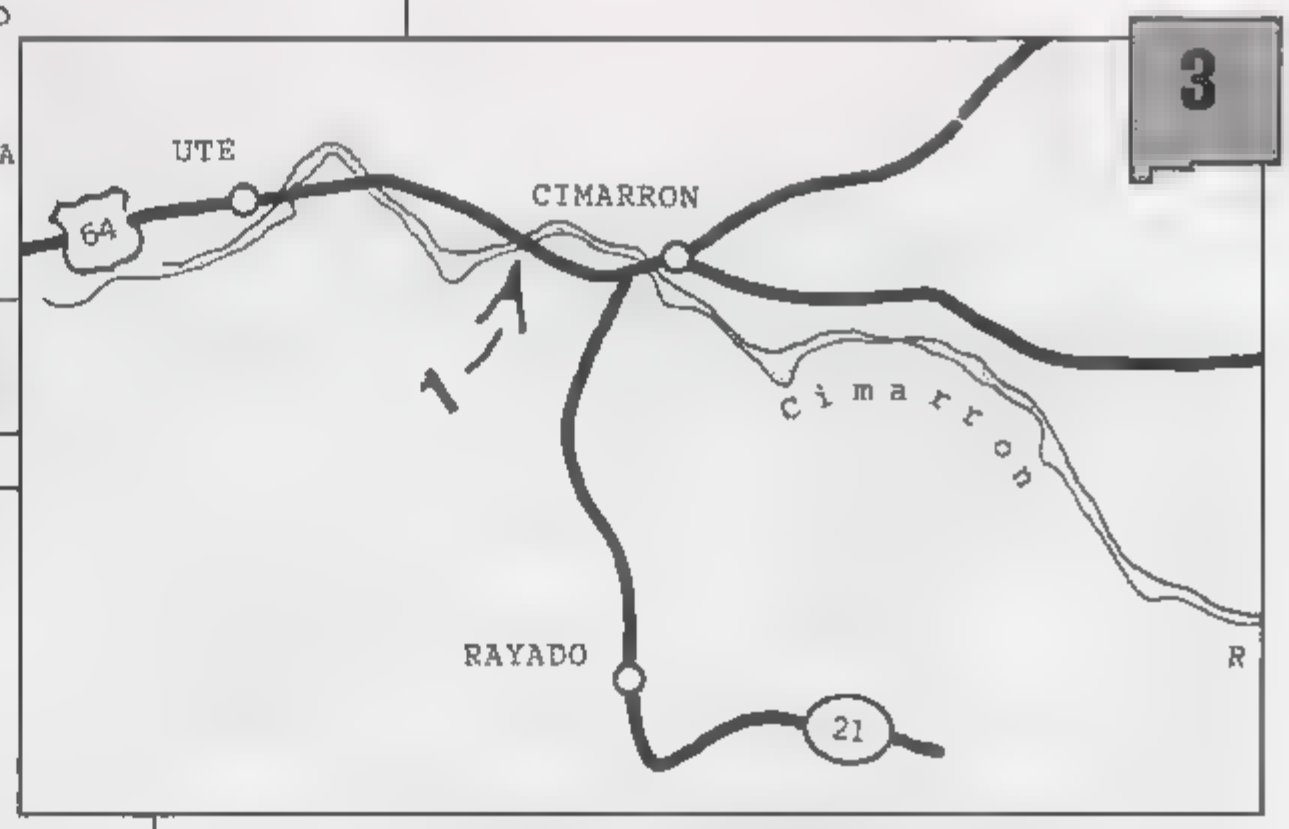
BERNALILLO COUNTY (MAP NM1)

Site 1 **Rio Puerco River/Interstate 40** crossing near **Albuquerque.** Vicinity finds include agate, chalcedony, jasper, opalized wood, and silicified wood.

Site 2 **Rio Grande River/County Road** crossing near **Alameda.** Vicinity finds indicate gold potential.

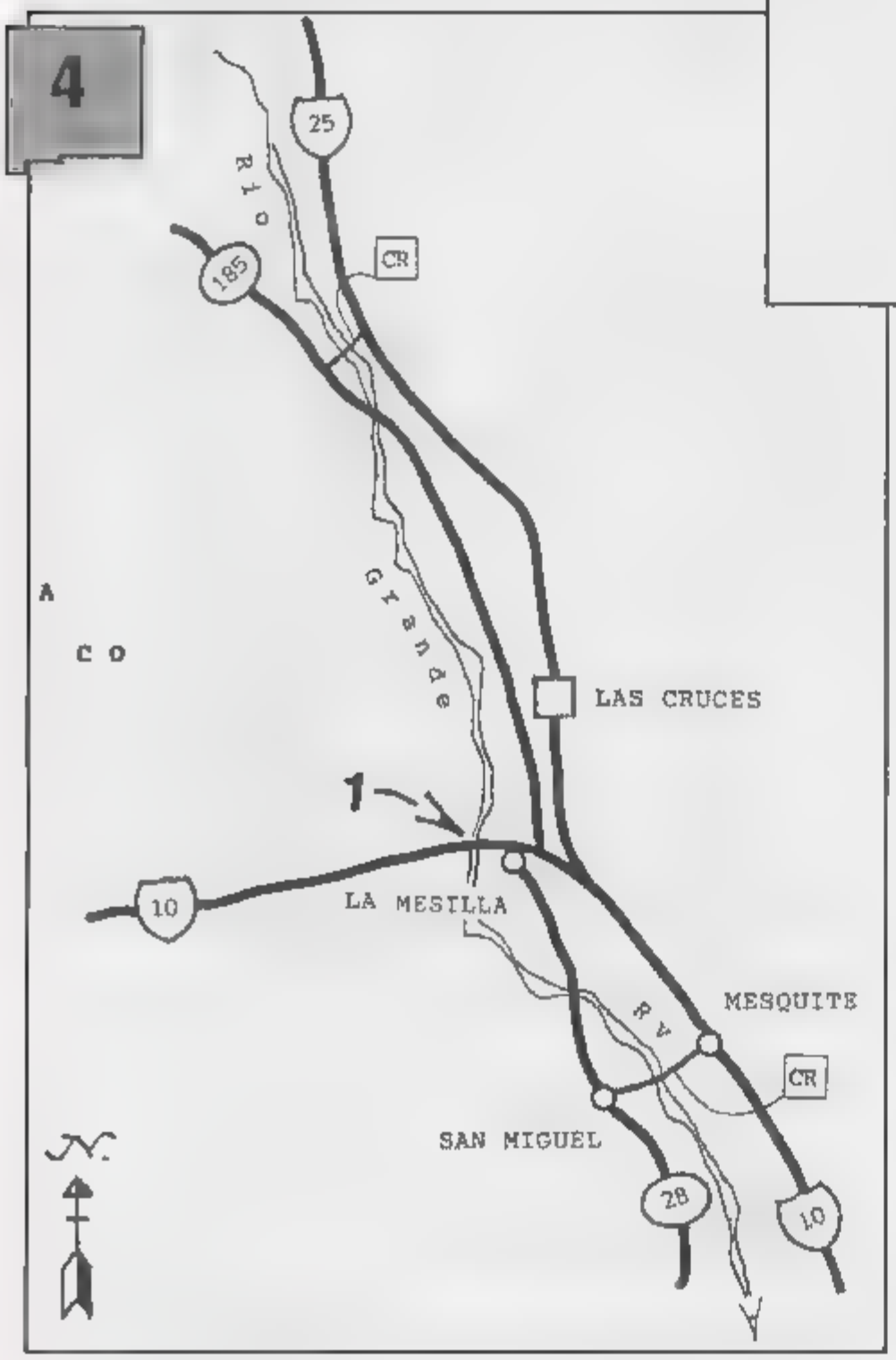
CATRON COUNTY (MAP NM2)

Site 1 **San Francisco River/U.S. Highway 180** crossing near **Alma.** Vicinity finds include agate, chalcedony and jasper



COLFAX COUNTY (MAP NM3)

Site 1. **Cimarron River/U.S. Highway 64** crossing near **Cimarron.** Vicinity finds include garnet and opal.



DONA ANA COUNTY (MAP NM4)

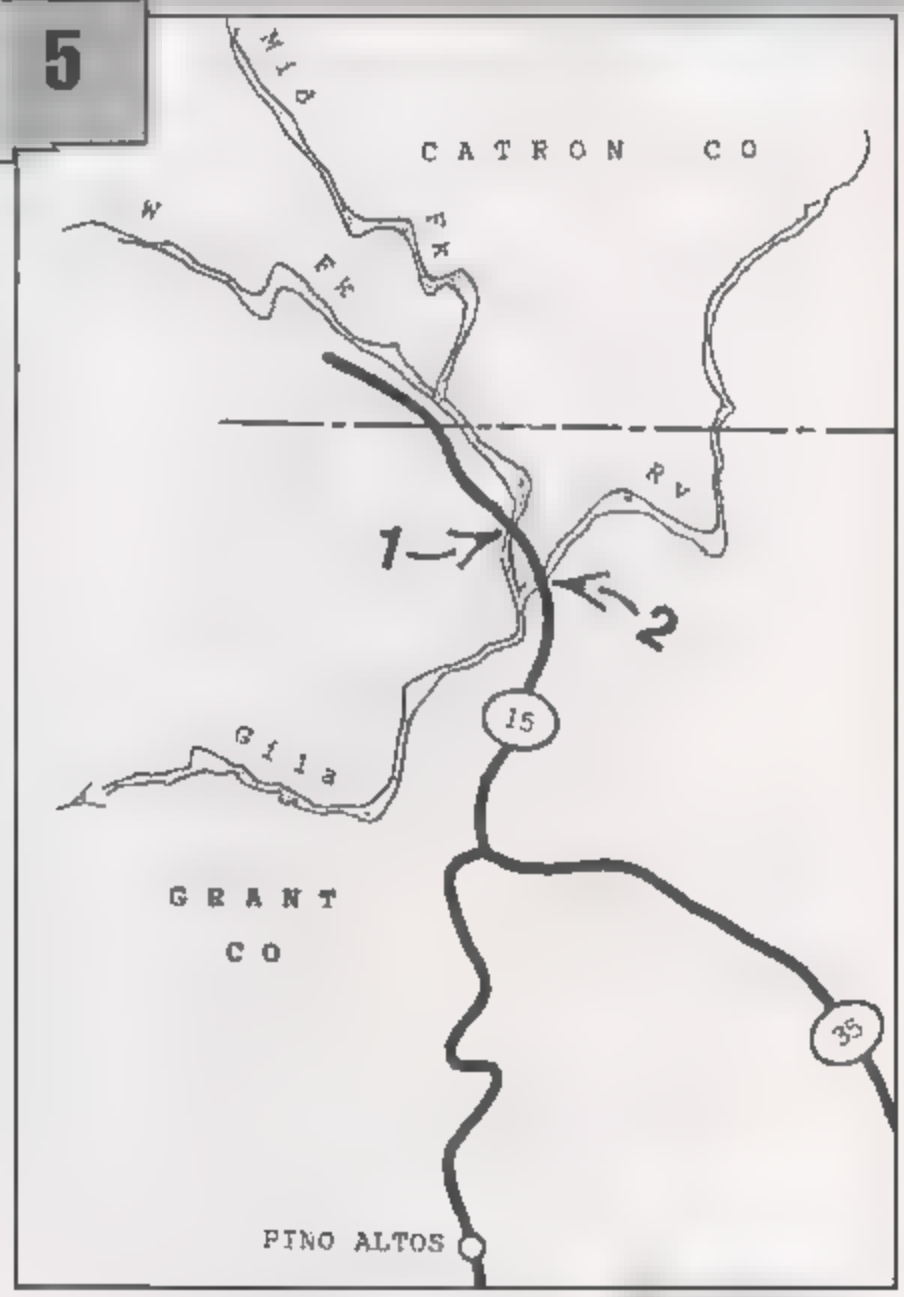
Site 1 **Rio Grande River/Interstate 10** cross ng near **La Mesilla.** Vicinity finds include chrysocolla, onyx, silicified wood, and tourmaline.

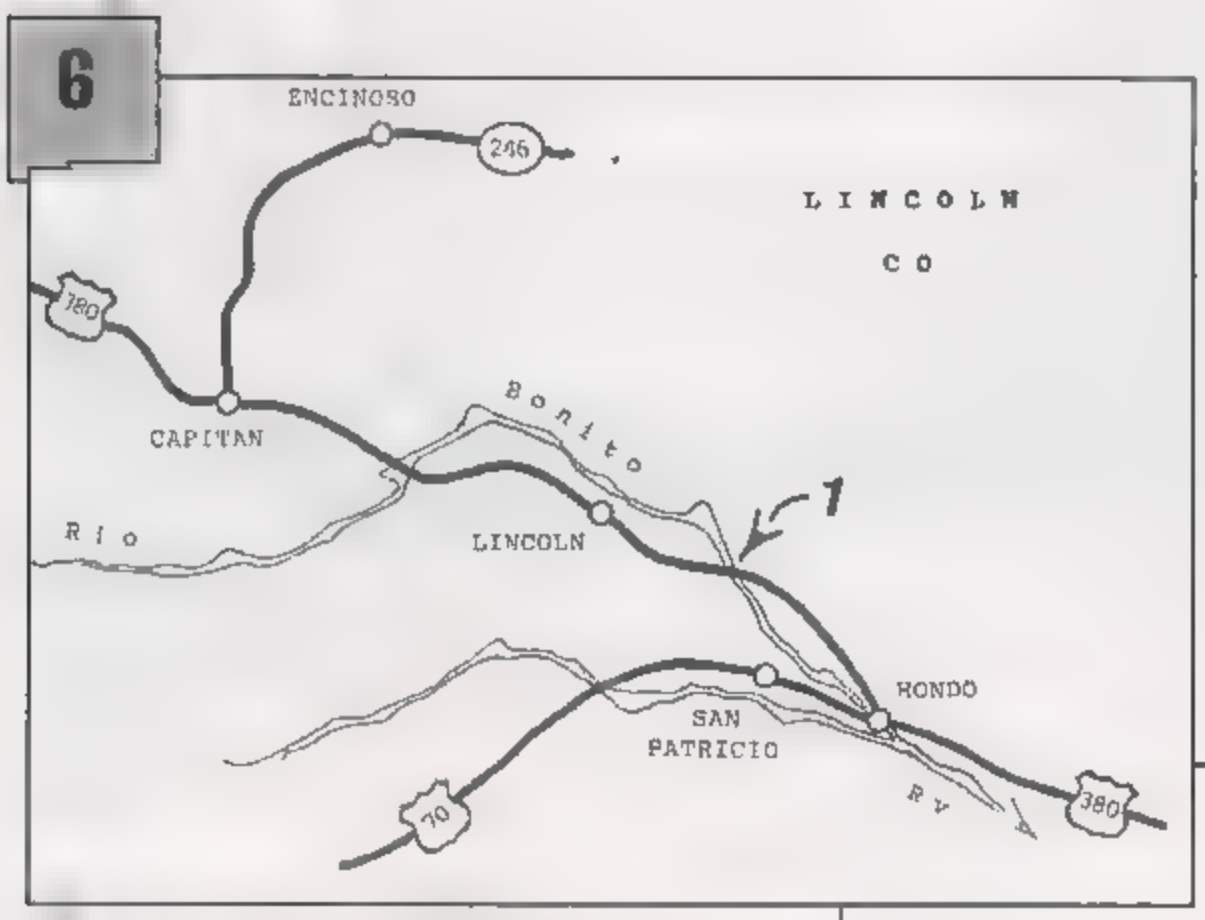
continued on next page

GRANT COUNTY (MAP NM5)

Site 1 **Tributary Gila River/state Route 15** crossing near **Pino Altos.** Vicinity finds include agate, chalcedony, jasper and topaz

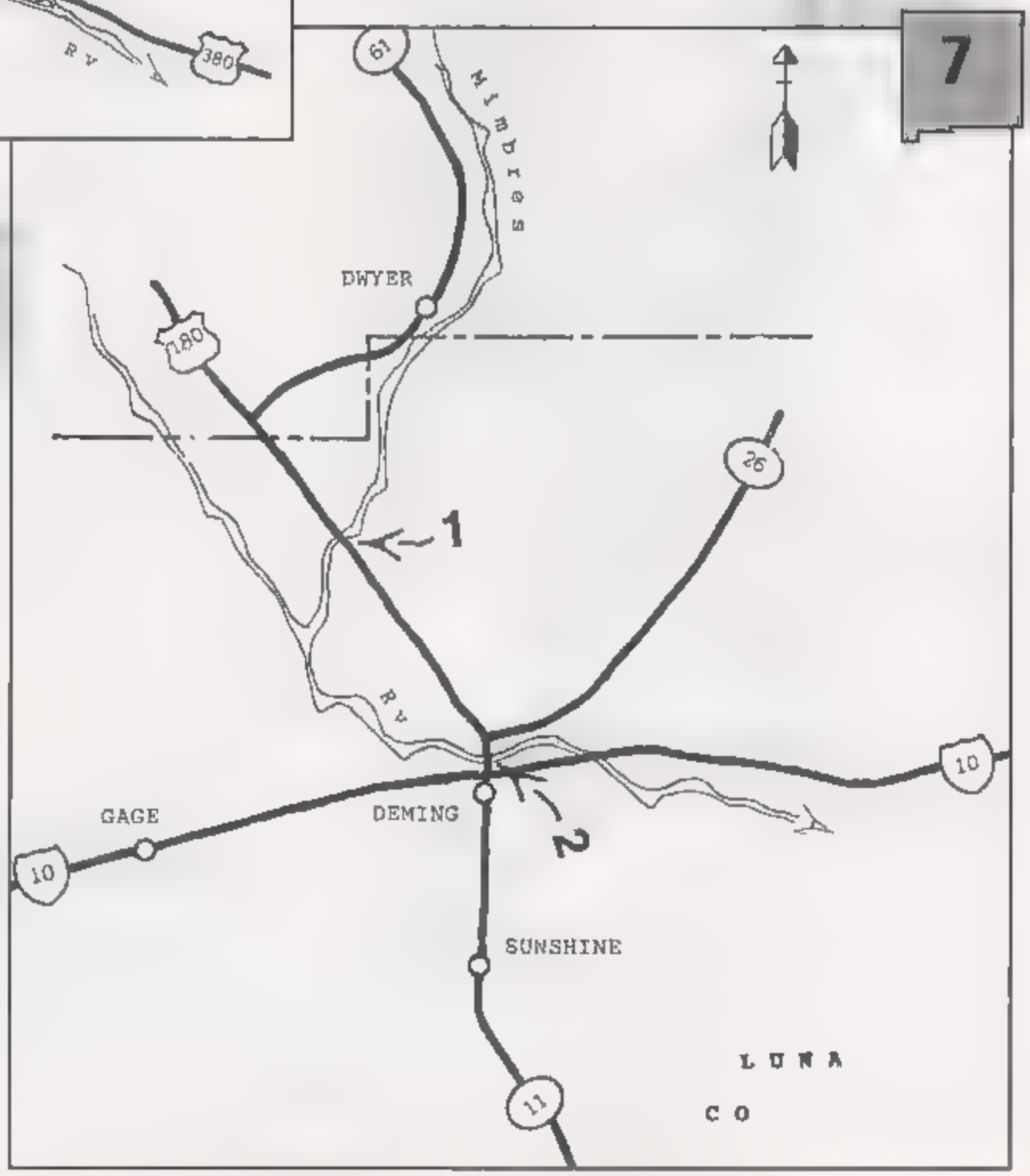
Site 2 **Gila River/state Route 15** crossing near **Pino Altos.** Vicinity finds include agate, chalcedony, jasper, and topaz





LINCOLN COUNTY (MAP NM6)

Site 1 **Rio Bonito River/U.S. Highway 380** crossing near **Hondo.** Vicinity finds indicate gold potential

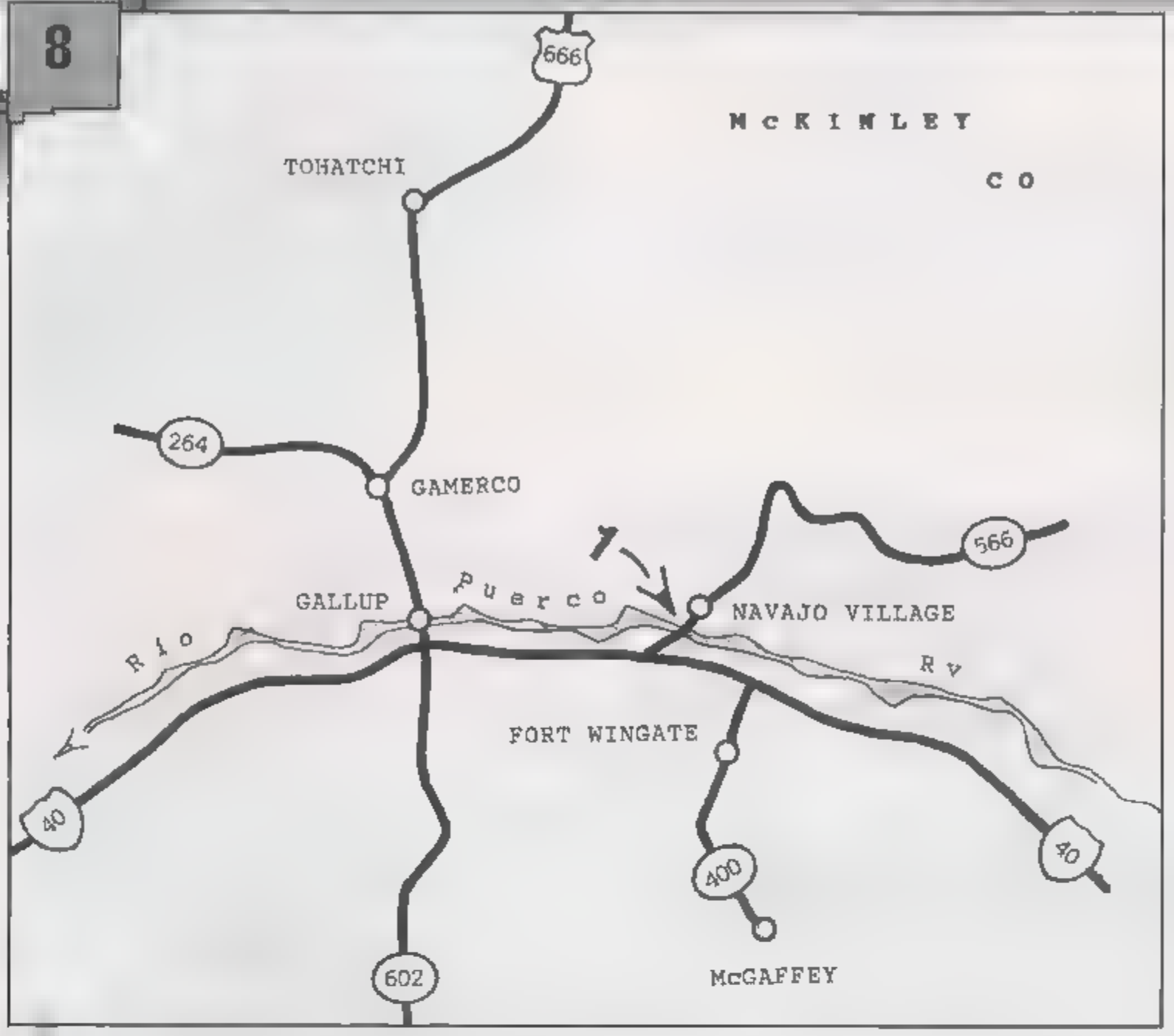


LUNA COUNTY (MAP NM7)

Site 1 **Mimbres River/U.S. Highway 180** crossing near **Deming.** Vicinity finds include agate, chrysocolla, chalcedony, gold, jasper, and quartz crystals.

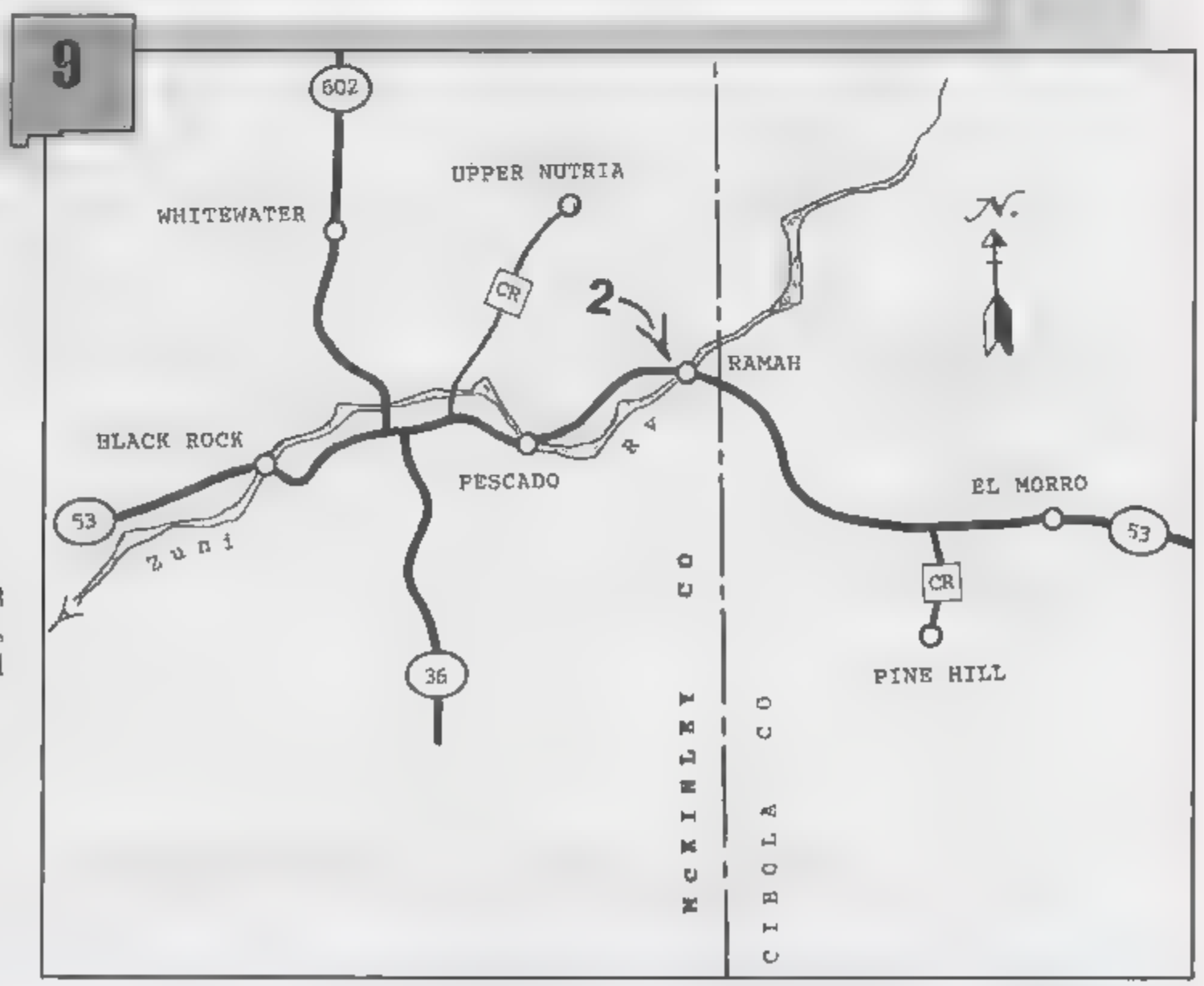
Site 2 **Membres River/state Route 11** crossing near **Deming.** Vicinity finds include gold, chalcedony and agate

continued on page 38



McKINLEY COUNTY (MAPS NM8)

Site 1. **Rio Puereo River/state Route 566** crossing near **Navajo Village.** Vicinity finds include agate, jasper, and silicified wood



McKINLEY COUNTY (MAPS NM9)

Site 2. **Zuni River/state Route 53** crossing near **Ramah.** Vicinity finds include agate, jasper, malachite, and silicified wood

The Gold Gastrolith of Calaveras County

A Tale of a Well-Traveled Nugget

Story and Photos by Glenn Wasson

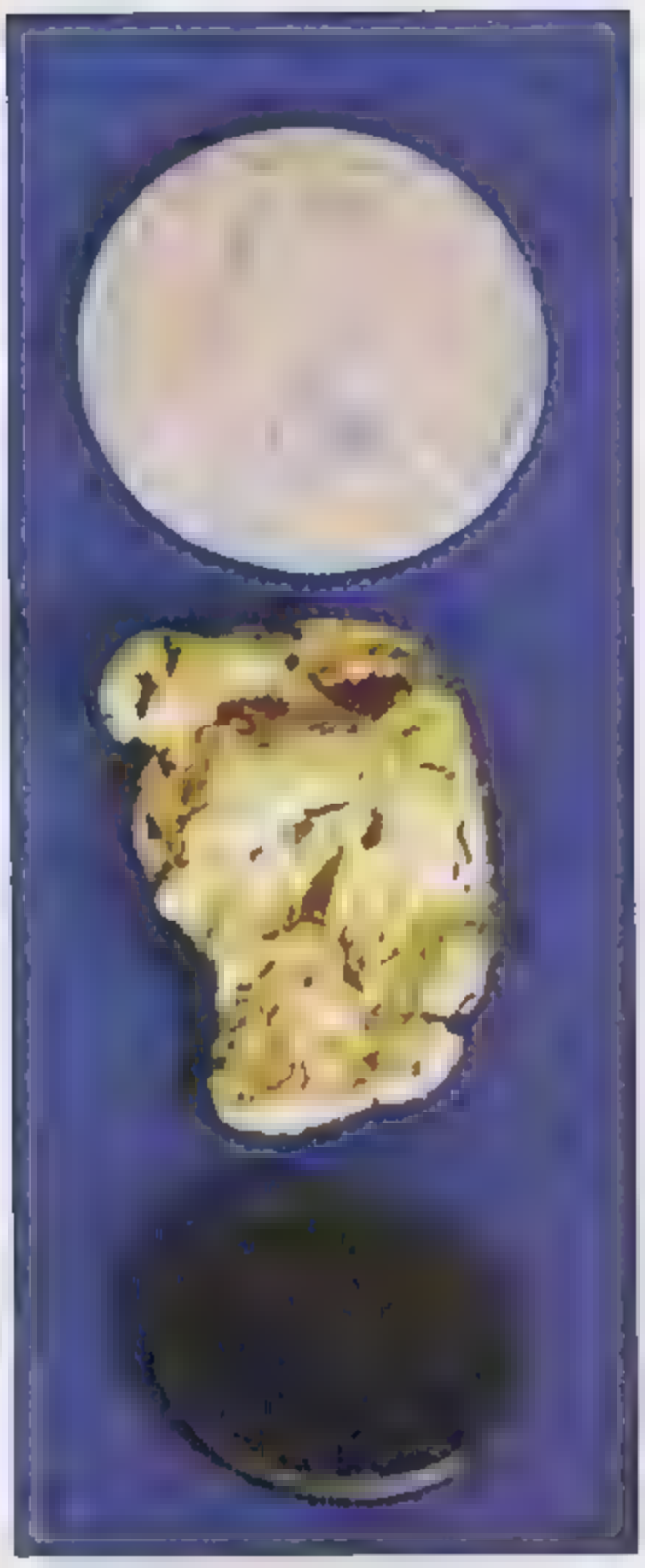
The nugget fits in the bowl of a spoon with room to spare.

Spectacular stories about gold and the odd adventures connected with this precious metal are commonplace particularly in Calaveras County and elsewhere in California.

Located in the heart of Mother Lode country Calaveras County may strike a cord in your memory for it was here that Mark Twain first witnessed and later wrote about frog jumping. His short story "The Celebrated Jumping Frog of Calaveras County" memorialized this unusual contest held in the early days by miners starved for entertainment. The piece launched Twain's remarkable writing career.

Even today, the frog-jumping contest is held at the County Fairgrounds at Angels Camp, just one town that grew out of the fevered rush of thousands of fortune hunters after the discovery of gold at Sutter's Mill in 1848.

The bar of the Murphys Hotel was the scene of one of the most unusual Calaveras County gold stories.



GLENN WASSON PHOTO

Tom Peterson s nugget took an unexpected journey through Tim Nolan's inner workings.

Today, Angels Camp still uses Twain's "Frog" as part of its tourist attraction and promotion. For that reason, and the fact that Angels Camp has a long history of gold mining, the 2006 California Federation of Mineralogical Societies held its 2006 gem and mineral show on the fairgrounds.

As part of the welcoming ceremonies at the Federation Show, I entertained the crowd by telling the most unusual tale of a gold nugget and a barfly who ended up in jail in 1987.

The Gold Country of California has certainly produced its share of fascinating stories, some involving the discovery of huge gold nuggets and crystallized masses. Other stories of derring-do and what might be called "odd events" involving gold and the people who lust for it have happened here.

Monster nuggets have surfaced throughout California's gold country. The largest piece of gold ever found on our continent came from Carson Hill in Calaveras County in 1854. The piece weighed nearly 200 pounds!

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Too Much To Swallow

Many tall tales are told in the old Mother Lode
From the pens of Bret Harte and Mark Twain.
To this treasure of lore upon us bestowed
Is another I'll attempt to explain.

One boisterous night in Murphys' hote
As the patrons lined up at the bar
An event took place too dubious to tell
'Twas unseemly, quite gross and bizarre.

A miner walked in with an obvious grin
And ordered drinks for the roistering crowd.
The bar settled down to let him begin
Which he did with a manner quite proud.

From out of his pocket, a nugget he'd panned
Was placed where everyone saw
To be fondled and hefted in each heavy hand,
An object of envy and awe.

As the drinkers inquired where the miner had dug it,
A patron slipped it into his beer.
Thinking "I'll have me that nugget, I'll just chug-a-lug it."
And with a gulp made the piece disappear.

The bar room was stunned but the miner was cool:
From out of his belt came a knife,
Saying, "Cough up the nugget, you guzzling tool,
If you want to enjoy further life."

The swallower coughed and inhaled but utterly failed
To foment a timely regurgence.
So, they slapped him in jail without any bail
To wait for the nugget's emergence.

A three day transition from mouth to emission
It was a well known medical fact,
Or so it was said by the local physician
Of a normal intestinal tract.

But three days passed by and he failed to expel
And this measurably heightened the tension.
A watch was put on to the prisoner's cell,
Now the focus of growing attention.

I cannot unveil in graphic detail
The nugget's final appearance
Decorum in poetry must prevail
Lest we offend its cultured adherents.

But it came to pass on the seventh day
When the guard heard the prisoner shout,
"Unlock my cell, I'm on my way,
That damnable nugget came out!"

The authorities gathered to examine the stool,
A procedure I could not recommend.
Not the normal discovery of gold as a rule
But all's well that comes out in the end!

Glenn Wasson

The Gold Gastrolith of Calaveras County *from page 41*

More recently, the Jamestown Mine in neighboring Tuolumne County gave its owners a wonderful gift, a group of superb leaf golds, the largest of which weighs 44 pounds. You can see that amazing bit of precious metal if you visit the Ironstone Winery in the town of Murphys, a few miles from Angels Camp. The gold is displayed in an open vault at the winery which boasts that this is the largest crystallized gold specimen on display anywhere in the world. You can enjoy a little wine tasting and see this great gold in the winery's fascinating small museum about Calaveras County's Gold Country.

Murphys is an old gold camp that has had its share of great gold events, but none is more renowned or grander than the Great Gold Gastrolith caper!

The size of the Gold Gastrolith is very average when compared with the tens of thousands of nuggets rescued from California's rivers and streams. But the story of its travels, which involves a bibulous gold lover, drew national attention.

Murphys Hotel was constructed in 1856 and is now on the National Registry of Historical Sites. Although the old camp's hotel has the names of many famous people on its register and its rooms have been the scene of many historic and unusual circumstances, its best known incident took place in the hotel on July 16, 1987.

On that night, Tim Nolan, of San Andreas, and Tom Peterson, of Angels Camp were in the bar at Murphys Hotel. After a few beers, Peterson produced a gold nugget he had panned and passed it around. Bar patrons admired it, hefted it, and enjoyed it. It was a nice nugget, half again as large as a nickel. It fit into the bowl of a spoon with room to spare.

The nugget was handed to Nolan in his turn. He looked at it, then dropped it into his glass and promptly downed the beer, nugget and all!

The startled Peterson immediately demanded his nugget back. He began pounding Nolan on the back, hoping to stimulate regurgitation of the gold. Despite these efforts and the unsolicited advice of surrounding bar patrons, Nolan did not cough it up. Then they took him to the men's room and hung him by his ankles. Nolan's brother, hoping to help, beat him on the stomach, but to no avail!

Unable to retrieve the gold nugget, the boys called the local deputy sheriff, who escorted the gold-bearing Nolan to the local hospital. Medical experts labored over him in hopes of recovering the "sunken" treasure, but the recalcitrant nugget remained firmly in place. This forced the deputy sheriff to arrest Tim Nolan on a charge of grand larceny.

The story, far too good to be kept quiet in Calaveras County, immediately hit the wire services of the United Press International and the Associated Press. The story was picked up by newspapers all over the nation. Radio commentators, always on the lookout for a funny story, also reported it for the amusement of their listeners. Television coverage quickly followed, and I've been told that Johnny Carson chortled in his monologue that drinkers in the Mother Lode town of Murphys spiked their beer with gold nuggets to give the brew a little more body!

continued on page 44

Gold Gastrolith *from page 42*

The story seemed to confirm widely held beliefs in America's heartland that, although California might be an interesting place to visit, it was still too freakish a location for ordinary people to live.

Since Nolan's gastrointestinal tract seemed adamant about retaining the gold nugget, medical authorities advised the group that it should not take more than three or four days for the insoluble object to pass through the digestive tract. Nolan was sent back to his boarding house in San Andreas and consigned to using a potty chair.

The district attorney's office, to keep track of the passing of time, hung a sign in the office that read "Nugget Watch Day," changing the number each day. But day after day, the nugget refused to show up.

After seven agonizing days had passed, so did the nugget. A welcome metallic clink announced to Nolan that the time had come. Literally relieved, Nolan showed the nugget to his landlady after cleaning it with a toothbrush, which he then discarded!

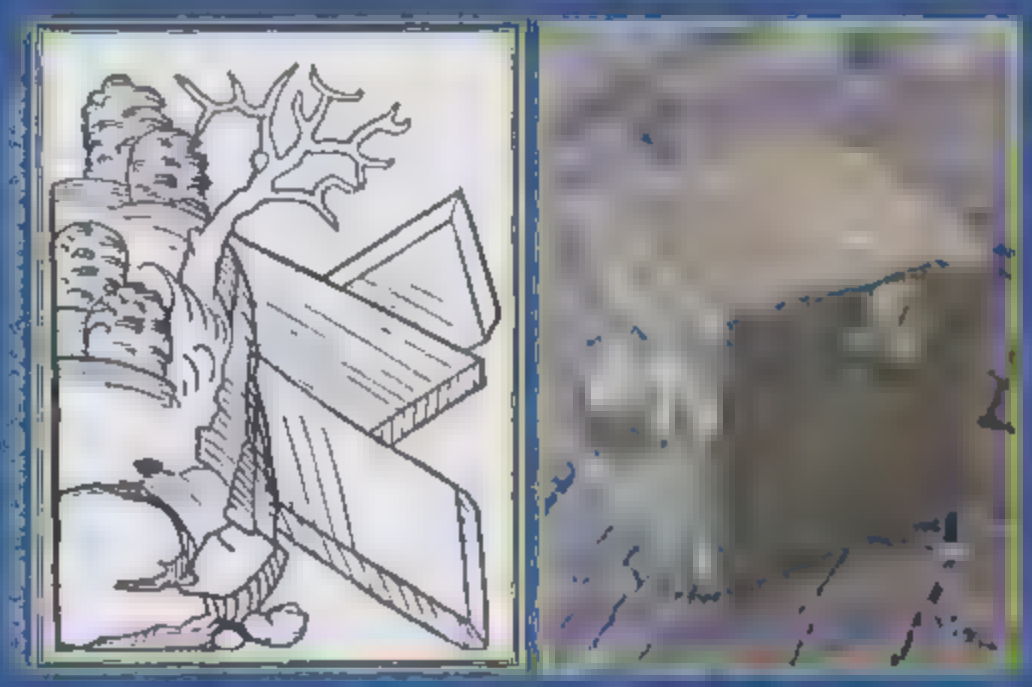
His landlady advised him to rush over to the District Attorney's office and surrender the ill-gotten gain. At the District Attorney's office, a little tomfoolery went on, during which time the nugget was passed around to all who were there. Then they penned the word "ceased" on the Nugget Watch sign and called Peterson.

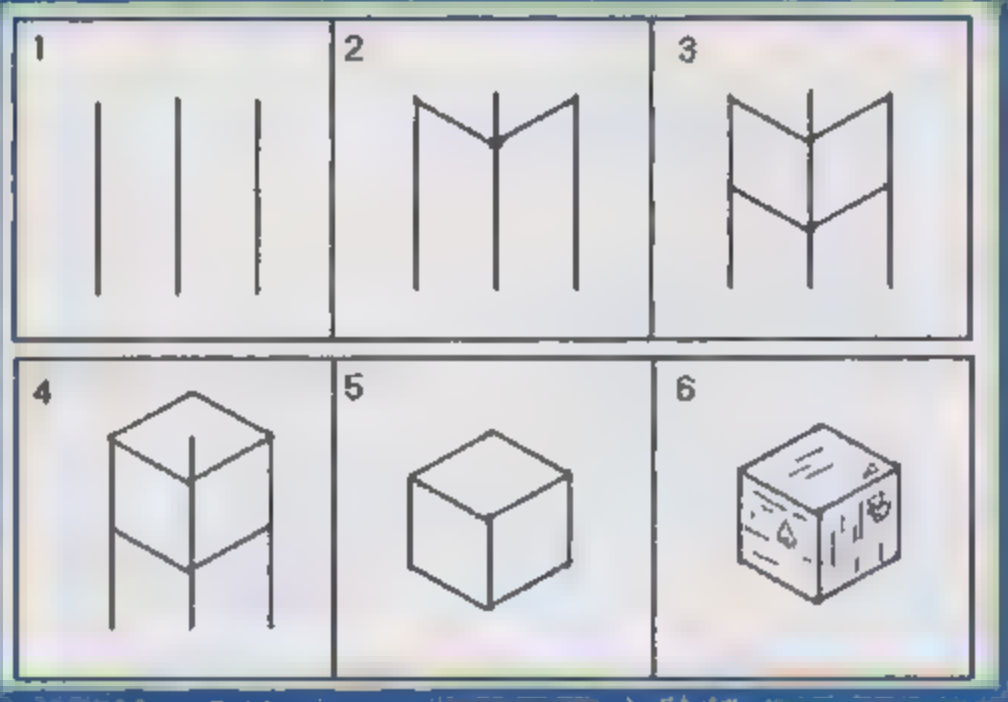
Of course, the press was notified for a photo session. Then the fun really began. The District Attorney demanded that Peterson prove the nugget was actually his! Luckily, the nugget had a distinctive shape, which Peterson described as resembling a buffalo on one side and a ghostbuster on the other! This satisfied authorities, and Peterson was reunited with his nugget, none the worse for its unusual journey.

There are several unverified stories about what happened to the nugget next. Peterson, in need of money, eventually sold it. There are also rumors it played a part in several drug sales later on. After years of searching, I finally tracked the nugget down by advertising that I would pay a premium far above the nugget's gold value for the nugget with an unusual true tale attached. When the gold was finally offered, its authenticity had to be verified once again. When I placed it next to newspaper pictures published at the time of its recovery, it proved to be a perfect match: a true gold gastrolith!

ROCK & GEM

Mineral Specimen and Crystal Illustration





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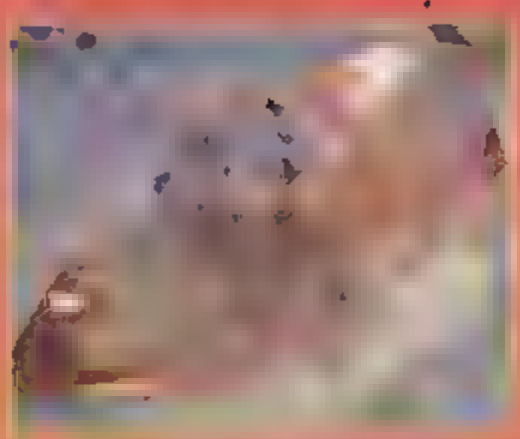

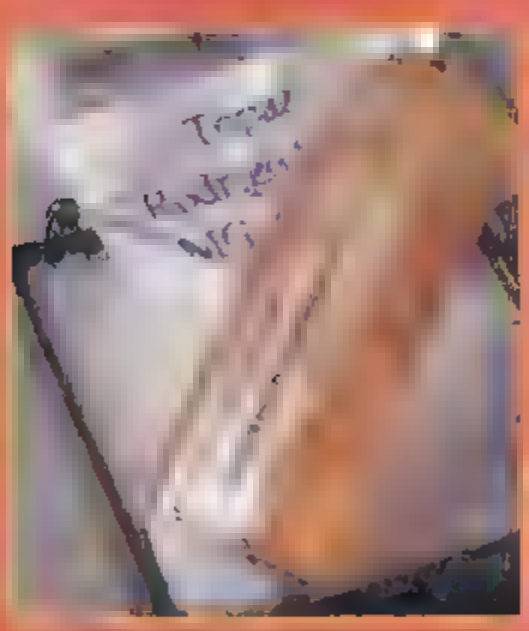

Rock & Gem Kids Quiz

The *Rock & Gem* Kids Quiz contest is open to U.S. residents age 18 and younger. All these questions can be answered by carefully reading this column. Write your answers neatly on a postcard or 4X5 card and mail to **January Rock & Gem Kids Quiz, P.O. Box 6925, Ventura, CA 93006-9899.** Valid entries received by **Jan. 31, 2007** will be entered in a drawing from which five winners will be chosen. Valid entries must be the entrant's own work and must include the correct answers, the entrant's name, age and address, and the signature of a parent or guardian. Prizes are generously provided by the Arizona Mineral and Mining Museum Foundation.

1. The earliest known publication of a mineral illustration was in the ____ edition of _____.
2. Give two reasons it would be helpful to have an illustration of a mineral.
3. Topaz is the state gem of _____ and _____.
4. Topaz must be handled carefully because it has a perfect _____.
5. Two ways to enhance the color of a topaz are _____ and _____.

FIELD TRIP

Golden Treasures in North Carolina

The large pyrites are the desired treasure from the Glendon pyrophyllite quarry

Collectors at the semiannual field trip dig in the pyrophyllite for large pyrite cubes.

Pyrite, Fluorite and Quartz Accompany Pyrophyllite

Story by Lori Lamb

In North Carolina, the months of October and April have little in common. October is the beginning of autumn, days grow short and leaves begin to fall. April is the rebirth of spring, when lengthening days yield the fresh green and pastel colors of the season. Yet for local mineral collectors, April and October have a common denominator: the semiannual trip into the Glendon Mine, a pyrophyllite quarry owned and operated by Standard Mineral Co

LORI LAMB PHOTO

The pyrite cubes reveal their shape and luster once cleaned of the pyrophyllite coating.

The company graciously opens this working surface mine to collectors twice a year, and the field trip is always well attended. A unique combination of minerals is found in the quarry, including massive pyrophyllite of various colors, quartz crystals, fluorite cubes and the ultimate prize, 1st size pyrite cubes.

Pyrophyllite is an aluminum silicate hydroxide in the dioctahedral subclass of minerals. The mineral has cleavage in one direction. It is sheetlike, with a flaky fracture. When heated, pyrophyllite exfoliates, leaving the silica sheets behind, unfused. These properties contributed to the naming of pyrophyllite, the term combines the Greek words for fire (*pyro*) and leaf (*phyll*).

In North Carolina, the concentrated deposits occur as elongated bodies or lenses that are longer than they are wide in volcanic breccias or tuffs of rhyolitic and dacitic composition. Pyrophyllite deposits in commercially mineable quantities are extremely limited in the United States, where there are only four active mines according to a 2003 USGS report. Three of these mines are in North Carolina. And while this makes the opportunity to collect pyrophyllite somewhat desirable, the associated minerals – specifically pyrite and fluorite – are what attract the hordes. The geological process that produced this combination of minerals actually began during Precambrian times.

The land that is now part of North Carolina was once closer to the large plate boundaries of the North American plate and the Euro African plate. Movements of these plates over time, and the relative direction of those movements, formed the underlying geological structure of modern North Carolina. Around 800 million years ago, the continental plates began to move away from each other causing rift valleys and small, intermittent zones of land called terranes. The Avalon Terrane was one such landmass.

On both sides of this terrane, shallow seas filled the rifts formed by the massive tensions caused by the plate separation. Around 750 million years ago, the plates suddenly changed direction and began to move toward each other. The boundary of the plate collision became a subduction zone, with one plate sliding beneath the other. This activity formed a series of island arc volcanoes along the Avalon Terrane. These volcanoes were active for the next 340 million years, producing lava, ash, tuffs and mud along their flanks and into the adjacent sea, known as the Iapetus Sea.

Over time, this same region experienced geysers and active hot springs. Depositional remains of the volcanic fields of the Avalon Terrane are found in the rock units of the Carolina Slate Belt. This region, which essentially bisects the state from northeast to southwest, contains the known pyrophyllite deposits in North Carolina. Geologists have determined that the pyrophyllite zones were formed by a series of impacts on the volcanic ash.

The initial impact appears to have been the thermal activity of the ancient geysers and hot springs upon the existing ash layers. Later, torturous and complex folding and faulting and its accompanying metamorphosis finished the process of forming these concentrated mineral zones. Within the state, Montgomery, Moore, Orange and Randolph counties all have documented pyrophyllite deposits, though not all are actively mined. Mining of pyrophyllite dates back to the mid-1800s, a time even before the mineral was accurately identified.

Jasper Stuckey, a former state geologist, published the first comprehensive evaluation of pyrophyllite deposits in North Carolina in 1928. Dr. Stuckey captured the known history of the mineral in his account "The Pyrophyllite Deposits of North Carolina" (NCDCD Bulletin #37, 1928). According to Dr. Stuckey, the first discovery of pyrophyllite in the state is undocumented. In the early 1800s, the mineral had not been distinguished and was often referred to and used as talc or soapstone.

As early as 1825, D. Olmstead documented talc and soapstone deposits in the Carolina Slate Belt, and some reason that these may have actually been pyrophyllite deposits. The deposits near Glendon, in Moore County, were first detailed by Ebenezer Emmons in a report published in 1856. Emmons also was the first to test these pyrophyllite deposits using a blowpipe. He found that the substance contained aluminum, making it chemically different from talc and soapstone, and firmly establishing it as a different mineral.

In 1913, C. Hafer called attention to the pyrite-bearing veins of quartz often associated with the pyrophyllite occurrences in the region, though no size or specifications are specifically noted. As far back as 1928, the mineral deposits had already been evaluated, and the quartz, chloritoid, sericite and pyrite associated with the deposits were all acknowledged. Stuckey postulated that, in the sequence of metamorphosis, the pyrite and quartz actually formed first, followed by the chloritoid and finally the pyrophyllite and sericite. The fluorite found at the Glendon site is not mentioned in the early literature, but begins to appear in references in the 1950s.

continued on next page

The pyrite cubes found at Glendon vary in size and shape

Mining of pyrophyllite dates to at least 1855, with the Womble Mine and the Phillips Mine both in the Glendon district, being the first established sites. Early uses included cut stones for chimneys, fireplaces and stove linings. The blocks of pyrophyllite were well suited to these uses because they did not shrink or chip when heated, were easy to cut and hardened as they weathered.

These features also explain the mineral's early use in grave markers, some of which date to 1840 even though there was no documented organized mining at that time. It was also used as tailor's chalk and as marking crayons in North Carolina's early gold mining industry. North Carolina was the largest gold producer in the country before the famous 1849 California strike, but alas, that is another story.

In 1918, Paul and Charlie Gerhardt prospected and developed a pyrophyllite deposit near Cabin Creek in Moore County. Standard Minerals acquired this interest in the 1920s and executed underground mining in the concentrated mineral zones. The Gerhardt brothers continued their prospecting efforts in Randolph County, developing deposits there. By the 1920s, pyrophyllite was competing with talc in the cosmetics industry, and in 1927 the R.T. Vanderbilt Co., Standard's parent company by then, introduced the mineral as a raw material for the ceramics industry. This broadened the demand, and mining escalated at the Cabin Creek site.

The high refractory characteristics of the mineral expanded its potential uses in the years following World War II. In the last 50 years, pyrophyllite has been used extensively in agricultural chemicals and insecticides, paint, drywall filler, industrial coatings, firebrick, sealants, and caulks, while maintaining its place in the ceramics industries.

The exact origin of the Glendon pit is unknown. Literature reports this site as the "old Ward Mine," but I could not locate any additional information on this reference. The two mines, Glendon and Cabin Creek, are frequently documented together as both are now Standard Mineral properties. In 1966, underground mining at Cabin Creek ceased permanently, and aboveground mining began. Now both sites host open pit mines. Between the two, the reserves are estimated to be in excess of 100 years given current market demand.

Fortunately for collectors, bringing the mining aboveground has created collecting opportunities not only for pyrophyllite, but also for the more desired secondary minerals. Mining the soft material does not requiring drilling or blasting, but can be messy when it rains. The ore is processed at the company's mill in nearby Robbins, North Carolina. The two mines contributed 75 percent of the domestic pyrophyllite produced in the United States in 2003 according to U.S. Geological Survey Mining Summaries.

Collecting at Glendon is with permission only and at the discretion of Standard Minerals Co. The main draw is the pyrite cubes found within the mounds of pyrophyllite. Some are quite large, reputed to be cinder block-size. Tell that to any collector and they almost become rabid. To quell the frequent club requests for access, Standard established prescheduled semiannual trips into the pit and opened them to clubs and individuals who signed the appropriate waiver of liability and an understanding of the rules. These trips are now well attended by folks from as far away as Ohio and Florida. Though some regulars never miss a trip, I have attended three times.

Traversing the open pit is akin to walking on soap flakes and caution must be exercised. On a sunny day, the glare from the mounds of pyrophyllite can be blinding at first and takes some visual adjustment. Additionally, one can expect to get anywhere from dirty to nasty, as the flaky material sticks to everything: clothes, shoes, skin ... and is particularly tenacious when wet. For each collecting trip, the quarry designates numerous piles that are open to collecting and digging, while other areas are roped off. Climbing on the walls is not allowed.

The pyrophyllite here occurs in massive form with a Mohs hardness of 1.5. It forms in lamellar sheets, unlike the radiating pyrophyllite sprays from nearby Orange County or those famous specimens from Graves Mountain, Georgia. As such, most collectors ignore this as merely the matrix for the pyrite. However, the pyrophyllite can be very attractive. Some areas of the pit produce specimens of varying shades of pink, purple and red. This is likely due to staining from secondary minerals such as hematite. The banding it produces provides a unique specimen. My personal favorite is a piece that is banded with purple inclusions.

Also present in bands or sprinkled within the pyrophyllite is the chloritoid identified here back in 1928. The chloritoid is so concentrated in some areas that it appears as massive, dark-green pyrophyllite. Since the 1950s, the variety of chloritoid identified at this site has been ottrelite. Ottrelite is a silicate mineral of flaky, hexagonal habit, similar to the micas, and appearing to the naked eye as a green speck in the cream-colored pyrophyllite. However, under the stereoscope, these crystals first described in Ottre, Belgium, in 1819 appear as stacked hexagons of olive-green color. With a hardness of Mohs 6 to 7, they are much harder than their matrix.

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Truthfully though, most collectors do not frequent this quarry for the pyrophyllite or the ottrelite specimens; it is the pyrite cubes they seek. For those upon this quest, the order of the day is digging. They come equipped with two main tools: a stout shovel and a metal detector. The pyrite occurs in intrusions in the pyrophyllite body and is frequently mixed in with the material when excavated. The texture of the flaky material causes the pyrophyllite to adhere to the cubes and the pearly luster reflects light, making it almost impossible to visually distinguish the pyrite merely by walking and looking.

Hunting at this site involves senses not usually engaged for mineral collecting: that of touch when sifting through the piles of powdery matrix and that of hearing for those using a metal detector. The consistently successful collectors here alternate between digging and listening. The pyrophyllite can serve as a sort of insulator and smaller cubes may be completely missed. The larger cubes, though, do seem to initiate enough of a signal to make the effort worthwhile. And for most, the larger cubes are the desired target.

LORI LAMB PHOTO

Footing can be slippery, and care is needed when climbing on the pyrophyllite.

My family's first trip was in April 1997. Armed with garden trowels, and not quite knowing what to expect, we joined members of our local club. Luckily, there had been very little rain that spring, so the quarry was fairly dry. Mounds of powdered pyrophyllite were waiting to be loaded and transported to the mill. I recall thinking that this must be similar to working on moon dust. After scouting the situation, we settled about halfway up the side of one of the smaller mounds and imitated those around us in digging. It really didn't take long for the work to pay off, for it seemed that we had picked a fortuitously prolific area.

Working together, the three of us sifting through the pile found a small bucketful of pyrite cubes. Most were considered small compared to the site's reputation, averaging 2 to 4 centimeters down the long axis. Yet, what was lost in size was gained in shape and perfection. Most of the specimens were actually rectangular, even rhombic, not cubic, but they exhibited crisp edges and few defects. The largest pyrite recovered on that trip was about 6 centimeters. Still, we were very pleased with our finds.

My husband returned to Glendon in October 2000 on a solo trip. His particular focus on this trip was collecting pyrite cubes intact in the pyrophyllite and quartz matrix. He was somewhat successful, and returned with several pieces with pyrite cubes ranging from 3 to 7 centimeters. Unfortunately, another phenomenon of the specimens is that as they increase in size, their quality is compromised, a standard rule in most mineral specimens. The cube edges become less crisp and many exhibit secondary growth and quartz lesions that interrupt the shape of the pyrite. However, as representatives of the site, they still make decent cabinet specimens.

Our third and most productive trip was in October 2004. The week preceding the visit had been particularly rainy, and navigating the low spots with standing water reminded me of trying to walk in a life-size bucket of plaster of Paris. Most attendees had metal detectors and actually worked together in teams to listen and dig, following the source of the occasional rapid ticking heard through the headphones. We still did not have a detector, so we once again had to rely on random luck.

At first, we surface collected, watching for cubes that had been washed clean by the rain, and we found a few, but ultimately we dug. In the saturated pyrophyllite, cubes didn't exactly roll out, and it was a messy task determining whether the clumps held the desired treasures. Rubbing them somewhat clean was followed by a trip to the nearest puddle for a dunk. After three hours of collecting and an abundance of powder ground into my jeans, we had accumulated several large pyrites, most of them rectangular but 8 to 9 centimeters on edge. Of course, as with most of the larger cubes from the site, these had both natural re-growths and manmade dings, so none were "Logrono" perfect. Still, they were respectable specimens, well worth the effort.

The day seemed very productive for others, as well, for many visitors had buckets with similar-size pyrite cubes. As the day was waning, and after some collectors had already left, I suddenly heard yells. Clearly, someone had found something really good, so we all gravitated in the direction of the sound. I had heard about the huge pyrites but actually didn't put much stock in the mineralogical urban legends. Sure enough, there in a collector's hand, dripping from its quick puddle bath, was a pyrite rhombohedron the size of a large brick.

Looks of awe and envy spread across the faces of the group, and the lucky collector said he had been coming to Glendon for seven years looking for "the big one." It was a handsome specimen, and was surprisingly sharp and undamaged given its large size. This discovery led some to return to the hunt with renewed vigor. Soon, however, the appointed exit hour arrived and everyone packed it in, vowing that next time they would find their "big one."

One mineral found sparingly at Glendon is fluorite. In fact, Glendon is the only location within the region with documented fluorite. Sources from the late 1950s document cubes of fluorite in the quartz at the Glendon deposit. The only examples we have found were a few very small, pale green cubes with some damage within a vug in a mass of milky quartz. They do fluoresce a muted purple under short-wave ultraviolet light. The best sample I have seen from Glendon was a near-perfect 1.5-centimeter green cube perched neatly upon a large piece of quartz. A member of our local club found this and showed it around at a subsequent meeting.

The fluorite is usually small and is found by either breaking open the quartz or culling through a lot of quartz tailings, as prolonged exposure to the sun bleaches out the pale green color. Once this occurs, the fluorite fades into the host quartz matrix, and only the keenest eye can pick it up.

With such a variety of mineral specimens to collect and the attraction of the unique site, Glendon is certainly a necessary trip for any collector. And whether you make one trip or many visits, there are always good results. Those interested in more information may contact Randy Thomas at Standard Minerals in Robbins, North Carolina, by calling (910) 948-2267. Trips are semiannually in April and October on dates established by the company. See you there!

FIELD TRIP

Out-of-This-World Collecting

Chalcopyrite, Nickel Ore, and Shattercones in Ontario

Story by Pat Kerr / Photos by Dan Kerr

In 1971 and 1972, the Apollo 16 and 17 crews visited Sudbury, Ontario, to study the geological features of the Onaping Formation. Stories appeared in the media with the term "moonscape," and the community was hurt. Since then, 7,226,401 trees were planted as part of a land reclamation project, and Sudbury won international awards for its environmental improvements. But for rock collectors, Sudbury remains a moonscape.

Back in the 1970s, the Sudbury Basin looked like a moon crater. From an airplane, you can still see the distinctive outline of the 7-mile-wide 37-mile-long and 10-mile-deep oval hole. From the ground, you can see what NASA found so interesting, what most now agree is Earth's second largest and second oldest meteorite impact site.

The Sudbury Basin is 390 kilometers north of Toronto, just off Provincial Highway 69. Road construction crews spent the last 10 years blasting and crushing the rock cuts along the highway, so leave some extra time for collecting on your way north and back south.

Ruth Debick, is a geologist with Northern Development and Mines. She and her husband are executive members of the Sudbury Rock & Lapidary Society and actively plan the club's annual gem and mineral show.

According to Ruth, "In the mid-

The Onaping formation site, which was studied by NASA scientists, consists of 1,400-meter-thick glass rock breccias and textured igneous rocks

1960s, an American oceanographer by the name of Robert Dietz suggested that Sudbury might represent an ancient meteorite impact feature. Knowing that something called 'shattercones' are found at other meteorite impact sites known on Earth, he came to Sudbury looking for shattercones. He found them in abundance, all around the outside of the 'Sudbury Structure,' but not inside it. He suggested not only that Sudbury was the result of an impact feature, but that the ores were 'cosmogenic' in origin. Most scientists of the day rejected his ideas outright ." Now virtually everyone who works on Sudbury area geology believes there was a major impact here 1.86 billion years ago.

Shattercones are fractures in rock that are conical in shape. They indicate a high-energy impact. Barbara Moon, in her book *The Canadian Shield* (N.S.L.

Natural Science of Canada Ltd., 1970), says that shattercones are also found in the Nevada desert and result from nuclear tests. In Sudbury, all the bases of the cones point directly into the basin.

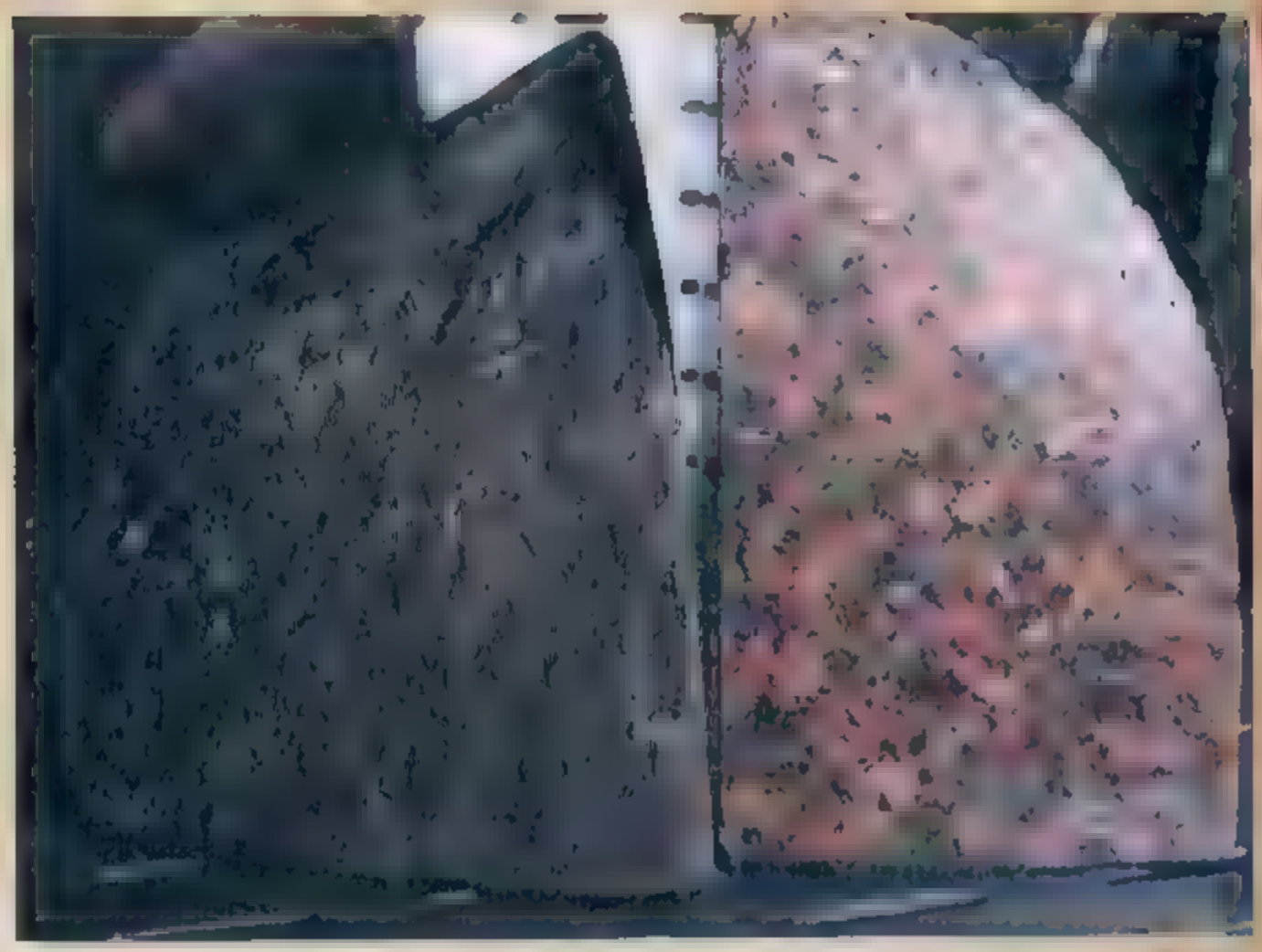
Another piece of evidence to support the meteorite theory is expressed by Bevan M. French of the Department of Mineral Sciences of the Smithsonian Institution. "Within the basin, the Onaping Formation, now identified as a tuff, back breccia from the impact event, contains clasts of basement rock with features indicative of even higher shock pressures, multiple PDFs [planar deformation features] in quartz and feldspar, melting of refractory minerals such as sphene, and formation of the heterogeneous airborne glassy bodies identical to the Fladen from Germany."

I visited www.enotes.com, an academic Web site, for some help with that. Shock metamorphism is instant change by extreme heat and pressure. Because quartz is common, it is used to measure shock stages. PDFs, microscopic parallel lines within the crystals, are measured at the far end of the scale. The next thing scientists look for is mineral melts and the rapid cooling producing impact glass. So Bevan French is proving this was an extreme event on the level of a nuclear blast.

Moon also said that one of the original theories to explain the unusual oval shape of the Sudbury Basin was a ring of volcanoes. This theory persisted for 80 years, but no volcanic source was ever found. There are no vents, no underground feeder system, and no deposits of ash scientists have looked. According to Sudbury Tourism, there are 3,107 miles of mining tunnels under the basin and if they were "placed end to end, you could drive from Sudbury to Vancouver underground."

ONAPING GEOLOGICAL TOUR

The Onaping Geological Tour is part driving tour and part walking tour. The tour area is viewed as the least deformed portion of the basin, which was also affected by two mountain-building episodes. Some of the trails are worth exploring, so take lots of water, snacks, bug repellent (in the spring for black flies), sturdy walking shoes, layered, appropriate clothing, and collecting equipment. Remember, it is a wilderness/picnic area with loads of blueberries, so be bear aware. Free maps are available at the tourist booths on the highway to Onaping. It is easy to find and well marked from Provincial Highway 144, but the maps show where the roads intersect with the basin. From Sudbury, go northwest on County Road 35, which will become Provincial Highway 144. Go through the hamlet of Dowling and watch for the signs. The tourist station is on the right and collecting is allowed.



A Sudbury bookend is reversed to show the deceptive effects of sulfur staining and weather on the surface rocks

The theory is that the meteorite, traveling at 30 kilometers per second, struck the Earth with the force of a nuclear blast. This caused a crater. Below the impact crater floor, the Earth cracked and molten material rose through the fractures. The combined heat and impact energy amalgamated the fragments of the Earth and the meteorite. At the same time, other rocks and sand were hurled skyward, these settled back by gravity. The molten material cooled and the geological cycle started again. Over time, rocks were compressed and worn down. Dimitrakopoulos describes the basin in three groups: Whitewater group sediments above Sudbury igneous complex (SIC), and brecciated footwall around the sides.

So today, the basin has four basic layers. They are the basal member, gray member, green member, and upper black member. At the tourist booth in the picnic area, you can see samples of the rocks from mines in the basin. They include chalcopyrite, pentlandite, pyrrhotite, granite breccia, granophyre, and disseminated ore. As you drive around the Onaping tour, you will see Sudbury-type breccia, matachewan-type dyke cutting, felsic norite, quartz gabbro, granophyre, gray member, black member, chelmsford formations, and onwatin. You will also see evidence of another dramatic impact on Sudbury-glacier movement.

I didn't find great collection samples of nickel ore or chalcopyrite, and I wanted some. So I called Ruth Debicki. Ruth reinforced the standard safety precautions for collecting in an area with a 100-year history of mining. Stay out of shafts, stay off private property, stay away from abandoned mines, don't trespass, be aware of old mine contamination hazards. She also said, "If there was any chalcopyrite showing at surface, it has almost certainly been mined."

Ruth said she gets her own samples from the annual Sudbury gem and mineral show or from the Nature Exchange. She said the children of local miners bring in "fresh" material that is not badly weathered or oxidized from being at the surface for years.

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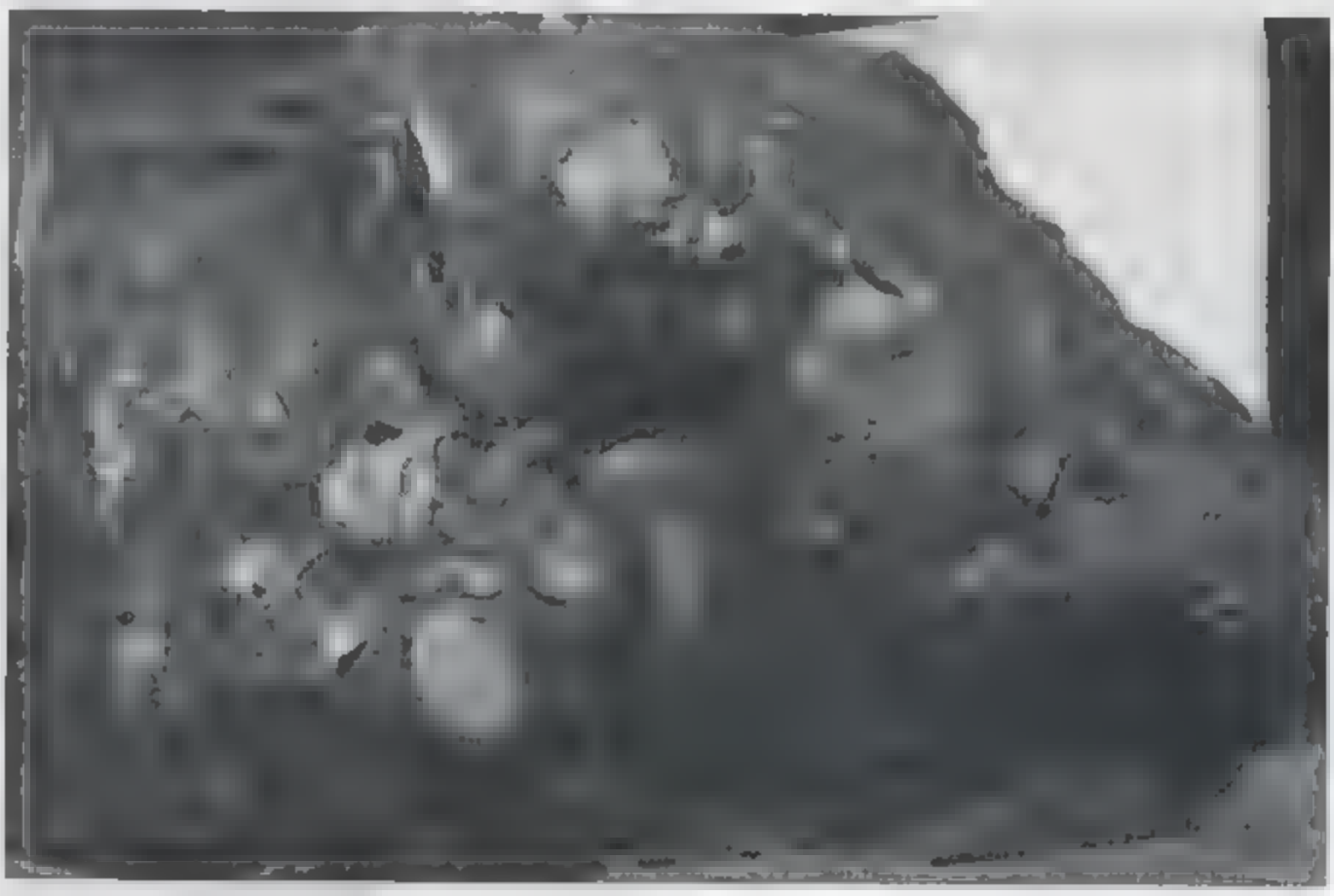

"Sudbury lava" is slag from the smelter. It is used as fill throughout the city.

SCIENCE NORTH/ THE NATURE EXCHANGE

Nancy Chabrand was supervising when I visited Science North and the Nature Exchange, and she was energetic about explaining the program. The one rule, she said, is to "leave birds nests, eggs, dead animals, and living plants and animals where you find them. Nature still needs them." You can bring in a couple of pinecones, some rock samples, or a collection to trade. The items brought in are assigned a value. A diamond has no more value to the exchange than a pinecone. This is an educational experience. Value is assigned for condition and knowledge. Visitors are encouraged to do research in the facility to add value to their collection. Then you can trade for items others have brought in. I had no difficulty obtaining shining samples of chalcopyrite and nickel ore for my collection at home.

While in Science North, we also took the audio geological tour. It described the Creighton Fault, which runs along the Trans Canada Highway from Sault St. Marie to Lake Wanapita. Science North is built on the fault and the main stairway was redirected to display the fault and the resulting geological impact. You will see glacial scratches and a black coating on the rocks and, most importantly, shattercones.

Call ahead when you visit these tourist attractions. They aren't cheap. They can be very busy with group tours or, like when we attended Sunday morning, you may be the only guests in the building for over an hour. The guides were energetic and eager kids, and if they didn't have the answer to your question, they were willing to do the research or find someone who did know.

DYNAMIC EARTH

With our admission to Science North, we also bought a pass to Dynamic Earth. Dynamic Earth is a 65-foot underground tourist display of mining on Big Nickel Mine Road. It was never an active mine. In fact, the site was chosen because of the lack of mining interest. No collecting is allowed in the facility, but I didn't see anything worth collecting, so there is no temptation.

If you take the underground tour, dress for 55 degrees F year 'round, and if it has rained recently, it will likely be still raining in the mine. There is a 65-foot deep glass elevator ride and several movies on the history of the basin, the meteorite impact, and Sudbury. We were guided through a display of mining from 1900 to the present, including a demonstration blast. The staff reviewed safety underground and core sample drilling.

We saw a multimedia presentation about Sudbury's history, including a description of early smelting techniques. It seems miners used to build piles of layered timber and ore 6 feet high over an area the size of a football field and allow the timber to burn for weeks. This explained the "moonscape" landscape and the need for replanting. The sulfur released into the air during the smelting process was a concern. In 1971, miners built a "superstack" that, at 1,250 feet high, was the highest free-standing structure in the world at the time, and this decreased the sulfur levels in the area. The smell doesn't seem to annoy the local people, but we watched the wind direction and established our plans to avoid the smoke burning. But I must say it cured my cold.

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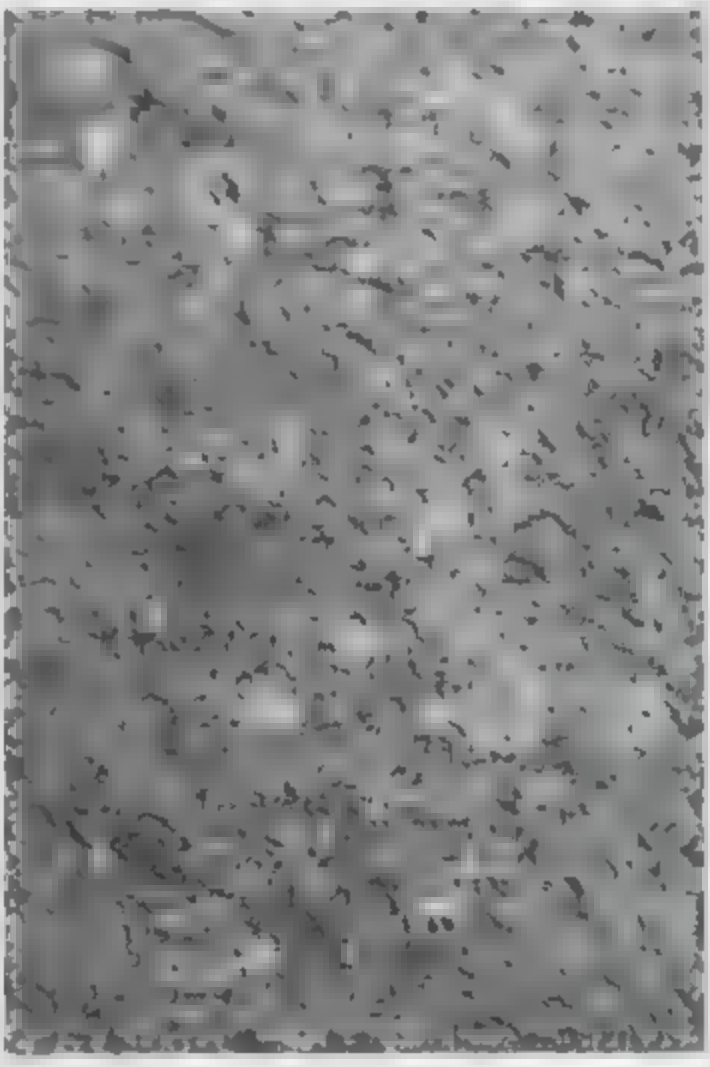

Fallback breccia is the result of the impact of an estimated 10-kilometer meteorite and is one of the unique features of the Sudbury basin.

I loved Dynamic Earth. It didn't have rocks to collect, but it had a fabulous children's display for rock identification. It also had a well-stocked gift shop. I was told a couple of local rockhounds make the Sudbury souvenirs. No one could tell me where the samples were collected, but it was obvious they weren't pieces smuggled home for miners' children. I was convinced nickel ore still existed on the surface.

COLLECTING

Inspired and now educated, I was back to collecting. Suddenly, I found nickel ore, "Sudbury lava" (slag from smelting), chalcopyrite, and igneous and sedimentary rocks literally everywhere. I collected samples from the fill beside Walmart, from the exposed rocks across from Bell Park, and in the rock cuts along the highway. It appears the tailings and slag were used as cheap fill throughout the city's entire history. I also followed the map, watching where the basin intersected with the roads, and looked in those areas for rock cuts. There are literally hundreds of sites. Certainly, I got my best samples from the Nature Exchange, but I found all I wanted in the field and left piles for the next collector.

The samples I collected from Sudbury are not the most beautiful in my collection. No one points them out and exclaims about their coloring or facets, but knowing their history, age and unique qualities, I treasure them as some of my best. After all, they are my only extraterrestrial samples.

Koyukuk River Gold

The author camps on the wide gravels of the Middle Fork of the Koyukuk in the shadow of Sukakpak Mountain

Prospecting In the Brooks Range

Story and Photos by Roger McPherson

Traveling north from Fairbanks, Alaska, following the 48-inch silver tube of the Trans-Alaska Pipeline, the Dalton Highway crosses the Yukon River before climbing into the Brooks Range to one of the more remote gold rush areas of the state. In 1898, after the Klondike creeks were all taken, prospectors spread out around Alaska, following the rivers or hiking overland in winter. For many years the Koyukuk River, a clear northern tributary of the Yukon, provided the only access into the Brooks Range above the Arctic Circle. Before the Dalton Highway (locally called the Haul Road) opened the way to the oil fields at Prudhoe Bay in 1974, shallow-draft riverboats, overland trails, and bush airplanes were the main methods of getting to Bettles, Coldfoot and Wiseman on the upper Koyukuk River.

The Silverado camp sits in the valley and the mining operation on the high bench of Smith Gulch

The BLM visitor center at the Yukon River has useful information about the Dalton Highway, and outdoor posters explain the history of the bridge and pipeline.

Gordon Bettles, a soft-hearted trader and prospector, managed to get supplies 365 miles up the shallow reaches of the Koyukuk by gas-powered boat, scow, and pack horses, and the town of Bettles grew around his "bean shop." The Tramway, Florence and Hughes bars in the Koyukuk River had enough gold to attract the first prospectors. Men working in the mountains would come downriver, and if they didn't have enough gold to pay for an outfit, they'd pan Tramway Bar to get gold for groceries at Bettles, 45 miles farther down. However, many of the 1898 stampeders left the area feeling that it only held "grubstake diggings" and not a bonanza. This "hungry" country only had a few seasonal caribou, moose, fish, rabbits, ptarmigan, grizzly bears, and berries.

The 100 or so prospectors who stayed discovered placer gold on Myrtle, Linda, Emma, Porcupine, Nolan, Marion, Minnie and Gold creeks and the Hammond River, 60 to 80 miles upriver from Bettles. "Sunburned" gold in the easily worked shallow gravels led to the founding of the town of Coldfoot at the mouth of Slate Creek in 1899, and later Wiseman at the mouth of Nolan Creek. Open-cut mining peaked by 1903 and new discoveries at Fairbanks began luring away some of the 300 hardy miners. A few inland Inupiat Eskimos moved into the communities, traded furs at the stores, and provided labor in the mines and female partners at the dances.

"When the Haul Road was opened up, it gave that area a breath of fresh air," George Lounsbury told me from his home overlooking the Ester mines near Fairbanks. A teddy bear of a man with a love of the Koyukuk's history, Lounsbury worked at Pump Station Five, mined on some of the creeks around Wiseman, and started a small museum at Wiseman. "It was probably the most remote strike in Alaska," he believed. "After freight got from Seattle to Bettles, it then cost double that to get it to Wiseman. The river was so shallow beyond Bettles that they had to use scows pulled by horses. That's why so much stuff up there is still lying around. People did a lot of improvising. You used what you had."

Two prospectors showed up in Nome in 1903 to record a discovery somewhere up the Koyukuk, but they wouldn't describe the exact location of their Midas claims. An accommodating judge created a new mining district, and he allowed the vague location of 64 claims to be recorded. After a trip Outside to raise capital for the Treasure and Midas Creeks Gold Mining Association of Alaska, the two promoters set out in a small motorboat bound for the Koyukuk River with stampeders in hot pursuit. The fraud was revealed after the men eluded their escort and departed Alaska. The large nuggets they showed off around Nome had indeed come from the Koyukuk, but they had bought them from a miner at Bettles.

Meanwhile, in 1907 three Swedes leased a small piece of ground on Nolan Creek and dug a deep shaft to bedrock. In three years, they took out over $250,000 in gold at $20 an ounce. A few years later, a deep channel was found under the benches in the Hammond River Valley. Wiseman developed from Wright's Roadhouse into a town, and Coldfoot was left to the mice and ptarmigan. Because of the extensive overburden covering the bench placers, miners developed winter drift mining with shafts reaching 300 feet deep and tunnels branching out along the paystreak.

"They'd sluice their dump in spring and be idle all summer unless they had ground they could mine with an open cut," Lounsbury explained. To prove his point, he pulled out an old ledger and pointed to an entry. "In the winter of 1905, Wannamaker had 10 guys working for him on Nolan Creek, putting in eight- to 10-hour days. They were driving points, shoveling, hoisting. They had to wheel everything from the drift to the shaft, hoist it, then use a trip line and carrier to the dump."

He shook his head at the hard labor involved. "In Wiseman, I've got 80 of those beat-up steam points. A lot of wood cutting went on around there for the steam boilers. In summer, the men would hang around Wiseman. There wasn't a lot to do. Winter was the big mining season."

Robert Marshall lived in Wiseman during the years 1930-31, and he wrote a detailed account of the people, mining and country in *Arctic Village*. He found that the 127 people living there still relied on mining and trapping for their subsistence living. Marshall felt a successful miner in the Koyukuk must be "a carpenter, a construction expert, a mechanic, a blacksmith, a cable splicer, a boiler maker, a steam engineer, a hydraulic expert, a logger, a geologist, and an economist. During his off hours he is supposed to be also a hunter, dog musher, cook, baker, and laundryman."

Failure and poverty were common, but even 78-year-old Poss Postlethwaite, after 32 winters in the country and facing blindness, wasn't discouraged. "In this country, a man doesn't think nothing of working all winter and getting nothing at all."

Late in life, Nellie Cashman, a familiar gold-camp character from Tombstone to the Cassiar in British Columbia, made Wiseman her last hometown. Her Midnight Sun Mining Co. had claims on Nolan Creek, and she was known to mush from Fairbanks to the upper Koyukuk. At 81, she finally left Wiseman and died in a hospital she helped establish in Victoria, British Columbia.

With the completion of the Dalton Highway through the Brooks Range to Prudhoe Bay, the Middle Fork of the Koyukuk River was released from its isolation. Coldfoot revived and became a regular truck stop, open all winter long. In 1980, Gates of the Arctic National Park was created, partly through the efforts of Robert Marshall's Wilderness Society and his writings. A visitor center in Coldfoot is operated by the Bureau of Land Management (BLM), U.S. Fish and Wildlife Service, and National Park Service from Memorial Day to Labor Day, 10 a.m. to 10 p.m. There are evening talks on the natural history, gold rush history, and culture of the area.

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Koyukuk River Gold *from page 71*

"In a big pickup traveling at a reasonable speed, it's about a six-hour drive without stopping," said Lenore Heppler, a Resource Interpretative Specialist with the BLM, about the 250-mile drive from Fairbanks to Coldfoot. "Factor in your driving habits, how much you stop. If it's been raining, the road gets wet and that will slow you down."

People who drive the Dalton Highway frequently encounter trucks on the way to and from Deadhorse and Prudhoe Bay hauling lengths of pipe, lowboys carrying oversize heavy equipment and prefabricated modules, and semis with bags of bentonite for drilling mud. The state has plans to harden the road surface, but drivers should nonetheless consider this a wilderness experience since the road is often far from civilization. A dependable vehicle, good tires and two spares, ample gas, camping gear, and supplies including food and mosquito repellant are necessary. The first facilities – a restaurant, rooms, and gas pump – are at the Yukon River bridge, about 140 miles from Fairbanks. The Yukon River access here allows locals river transportation to their fish camps and to Stevens Village.

"The BLM has a little log cabin – we call it the 'contact cabin' – on the north side of the Yukon River," Heppler told me. "Volunteers are available to answer questions from June through August from 9 a.m. to 6 p.m."

A small wood-burning stove warmed the Yukon visitor center cabin when my wife and I stopped in during a trip north. Red-haired Thelma Bowser greeted us, and offered brochures on fishing and gold panning, and a *Discover the Dalton* newsprint magazine. "Yesterday, we had 156 people," she informed me. Outside on a spacious deck were posters about pipeline history, the E. L. Patton Bridge (named for the man who was head of the Alyeska Pipeline Co. in 1975, when the bridge was completed), the history of the Yukon River, and other subjects.

Stopping only briefly at the Arctic Circle viewing deck for a few photos of the Arctic Circle sign, we continued driving north through the rolling hills, taking in the changing vistas of jagged mountains and the pipeline paralleling the road. At the Finger Mountain picnic area we investigated a short trail to the summit, reading the informative signs next to wildflowers as we strolled along.

Prospect Creek and the Jim River crossings (near Pump Station 5) are the first places to try gold panning before climbing into the Brooks Range, according to the brochure "Dalton Highway Recreational Mineral Collection." Pan concentrates from the Jim River reportedly had visible fine gold, possibly associated with the Jim River pluton that extends for 20 miles on the east side of the road. Since this is a low, brushy area, we didn't stop to feed the mosquitoes.

Soon after crossing the South Fork of the Koyukuk River (rated three pans by the BLM mineral brochure), the highway enters the spectacular Brooks Range, following the flood plain of the Middle Fork up to its headwaters in the Dietrich and Bettles rivers near Atigun Pass. Coldfoot, a welcome stop for a meal, gas and information, has seen some of the coldest winter temperatures, often exceeding 60 degrees below zero for weeks at a time. Its name was applied when an early group of prospectors who made it this far changed their minds – got cold feet – and turned back to civilization without setting up camp.

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Many of the gravel creeks are good prospects for "sunburned" gold.

Koyukuk River Gold *from page 72*

"Coldfoot was a very short-lived town," Heppler recalled. "People started moving up to Wiseman within 10 years. The old cemetery in Coldfoot was grown over. When the pipeline camp was built in Coldfoot, they rediscovered the cemetery. We've found out more about who has been buried there." She told me the story of a Frenchman who froze to death while bringing moose meat back to town in 70-below temperatures. Another man died trying to save his sluice boxes during a flood.

"Coldfoot is a natural overnight stop on the way from Fairbanks to Deadhorse," Heppler pointed out. "Our main campground is at Marion Creek, five miles north of Coldfoot. It's a developed camp with picnic tables and fire rings with 27 sites. Campground hosts are there, and a fee is charged."

One of our tires had been slashed by the sharp rocks along a section of road being constructed, and I was glad to find tire service in Coldfoot. Many other drivers had similar stories of tire problems. At the visitor center in Coldfoot, we looked over a huge topographic map on the wall, a display of native plants (a "tundra garden"), and other displays of animal tracks, pelts, and skulls. Chris Sutter and his wife, Debbie, double as the Marion Creek campground hosts and visitor center operators. Tour buses usually bring crowds for their evening programs.

"My program is about the three people rushes," Chris told me in a South Carolina drawl. "There was the gold rush, the black gold rush, and after 1985, the tourist rush that started with Princess and Gray Line tour buses. In '95, they opened the highway to private vehicles. We call them 'independent travelers.'"

Coldfoot was established at the mouth of Slate Creek because its upstream tributary, Myrtle Creek, had coarse gold on a three-mile section. From its mouth up to Myrtle Creek, Slate Creek had flour gold. The shallow gravels of the tributary were pick, shovel and sluicebox ground, easily worked shingle gravels. Gold the size of melon seeds and wheat grains was found across the width of the creek. Bench gravels on lower Myrtle Creek also carried gold that was mined by hydraulicking the ground.

"The early miners went to the shallow drainages," Lounsbury told me. "The creeks that first got staked were easy to mine. At $18 an ounce, they took out $1 million in gold off Myrtle Creek. Johnny Repo came in there in the 1930s and ripped the bedrock and he probably took another million out of $35-an-ounce gold." He smiled at the stories he'd heard.

"The first guys could see the nuggets lying right there in the creek! When I was there, we sank a few shafts. It was a well-worn trail, a lot of guys went over there. There's not really a road. We used to drive up Slate Creek on the bars, and watched out for high water."

After trying the first quarter-mile of the Slate Creek road, I turned back. Our tire mechanic had just spent a long night pulling a friend out of a low spot along this track.

I asked Lounsbury about other creeks near Coldfoot. "You go up the Middle Fork of the Koyukuk from Coldfoot and all the good mines are on the west side of the river," he told me. "Porcupine Creek below Coldfoot and Emma Creek were always good producers. On the east, Clara, Marion and Minnie didn't have much gold. A little on Minnie. Clara Creek is held."

Shortly after leaving Coldfoot, the road crosses Clara Gulch, Marion Creek, and Minnie Creek. About 13 miles north of Coldfoot, the highway crosses the North Fork of the Koyukuk River, allowing access to the Wiseman, Nolan Creek, and Hammond River areas. Wiseman, located three miles off the highway on the west bank of the Koyukuk River, retains many of its historic cabins and has a small museum. The town, once just a roadhouse, was a picturesque collection of historic cabins.

I asked George Lounsbury about Wiseman today. "The people that live up there now like to hunt and trap," he said. "It's a different environment than most people are used to. They get their moose in the fall. Twenty-five or 30 people live there. Most have seasonal jobs in summer."

In "South" Wiseman we followed a hand-lettered sign advertising handcrafted work to Jack Reakoff's cabin. Curly hair spilled from under his long-billed cap as he spoke to us around his kitchen table. "I trap all winter," he explained. "Wolves, lynx, wolverine, fox, marten. This is a wilderness country." He brought out jewelry made with wolf teeth, lynx claws, and glass and bone beads that he sells. Solar panels on his cabin roof captured the sun's energy for much of the year. His carefully-tended garden produced hardy potatoes and greens, as well as tomatoes.

"I'm not a miner," he admitted. "There's one guy up the Hammond. On Smith Creek, off Nolan Creek, Silverado did a deep drift and got a 41-ounce nugget out of it."

continued on page 80

Koyukuk River Gold *from page 74*

The unique conditions behind the creation of this "nugget district" are seen in both the Nolan and Hammond river valleys. The three kinds of placer deposits found here are shallow gulch gravels, bench gravels, and deep frozen gravels. Fay, Archibald and Smith gulches on Nolan Creek, Union and Confederate on the Koyukuk, and Goldbottom, Swift and Buckeye gulches and Vermont Creek on the Hammond had gold near their mouths that had been eroded down from lode sources in the schist around Midnight Dome and from the gulches down-cutting through bench gravel.

Bench deposits above the modern streams were laid down when the streams were flowing at higher elevations, probably because of damming by glacial ice. These may be the remnants of narrow beaches along the edges of a glacier-made lake when ice streams filled the valleys 300 feet or more above their modern floors. Basins formed during periods of glacial advance and retreat became filled with sandy sediment. Tributaries and gulches continued to bring gold to what were high beaches. Downcutting by modern streams eroded these bench placers and produced shallow creek placers that were the first to be discovered and worked. The most profitable bench placers were located on Nolan Creek where gold varied from rounded to angular nuggets with quartz fragments.

"There were glaciers that plugged off the Wiseman Valley," Reakoff said. "The old-timers found a lake there. Nobody has found anything that the old-timers haven't found."

The richest placers were discovered in 1906 in deep frozen gravels by sinking prospect shafts through 135 feet of frozen silts and clays. This third kind of deposit was created before glaciation or during interglacial periods, when deeply incised bedrock channels eroded the upland lodes. A thick blanket of overburden from glacial damming, moraines, and outwash covered these placers and they required underground mining with shafts and tunnels. The coarse, rounded, chunky nuggets found here were among the largest in Alaska.

The Hammond River Valley went through similar glacial advances and retreats, and the best placer areas were found within five miles of its mouth. Vermont Creek, tributary of the Hammond River, has been profitably mined since 1901, producing mostly coarse and rounded nuggets. Mineralized schist at its head has quartz veinlets with free gold in specks and flakes.

The 48-inch silver tube of the Trans-Alaska Pipeline dominates the landscape along the Dalton Highway.

"You can drive up there," Lounsbury told me. "It's a pretty river. The Hammond flows a lot of water; that's what killed the early mines. They got flooded out by 'live' water. Two huge dredges of the Detroit Mining Co. are up there yet. They planned to mine the deep channel, but there were a lot of stumbling blocks. It's deep, it's wet, and there's the river to deal with."

We drove up the Hammond Valley to where wild, purple sweet pea flowers filled the air with perfume. Along the open gravel bank, we had lunch with an unforgettable view of the surrounding mountains.

Returning to the Dalton Highway and continuing north, five miles beyond the second bridge over the North Fork of the Koyukuk River, the highway passes over Nugget, Sheep, Gold and Linda creeks, which all had fair to good prospects according to USGS geologist A.G. Maddren in Bulletin 532 (1913). Linda Creek had fine gold and Gold Creek had shot-size pieces and nuggets along a six-mile stretch.

"You get 12 to 14 miles north of Wiseman, you've got three or four creeks that produced gold," Lounsbury stated. "Sheep, Linda, Gold. Gold Creek has three or four people on it. John and Ethel Hall have got a drift mine on Linda."

Keith "Woody" Woodward, the BLM's Mining Compliance person, told me about mining along the Alyeska Pipeline corridor. Dressed in the typical forest-green shirt and pants I associate with park rangers, he wore a beard and a ready smile.

"The inner corridor, usually a mile on either side of the pipeline, is closed to mining claims," he carefully explained. "The outer corridor is open to claim staking. However, the inner corridor is open to casual use: pan and pick and shovel, but no mechanical equipment, so no suction dredging. The whole idea is to protect the pipeline."

The Recreational Mineral Collection brochure warns the public to stay at least 100 feet away from the pipeline.

"You also don't want to be on someone else's federal mining claim," Woodward advised me. "There [are] a few still left. Linda Creek has some, [and] Clara Creek. Nolan Creek is basically controlled by Silverado. Hammond is the same."

The good news is that within the mile-wide pipeline corridor, most of the smaller creeks have opportunities for gold panning. The BLM Recreational Mineral brochure lists the open areas for each creek. Most are open a mile upstream from the road (Clara Creek is only open for a half mile and Linda Creek is claimed), for those who are prepared for the long drive, the Koyukuk offers unlimited areas to investigate.

Robert Marshall felt that the overpowering loveliness of this Arctic wilderness influenced the happiness of the inhabitants. He concluded, "A person misses many things by living in the isolation of the Koyukuk, but he gains a life filled with an amount of freedom, tolerance, beauty and contentment such as few human beings are ever fortunate enough to achieve."

Hiking up a gravel creek and finding a secret cleft and waterfall showed me the enchantment of these high valleys. A rock spangled with bright yellow chalcopyrite suggested a copper deposit upstream. Numerous wildflowers and several varieties of berries covered the forest carpet. Bear tracks were imprinted in the creek sand. Waking in the morning at a campsite on a wide gravel bar, I marveled at the colors of the marble and schist mountains. Food, indeed, for the soul, and gold in the creeks for the hardy few who called this home.

A Shared Passion

How Rockhounding and Lapidary Helped My Marriage

Story and Photos by Craig Andrews

We tried making art together, being a writing team, doing sports activities, taking salsa dance lessons, and singing together, but the shared passion we sought eluded us for the first year or so of our marriage. My wife, Miriam, and I are both passionate people, hence, having shared passion in our relationship evolved into the ultimate albeit elusive goal.

Discovering (or rediscovering, in my case) the joys of rockhounding and lapidary has proved to be key in forging a marital bond stronger than Epoxy 220. While it would be stretching things to say that rockhounding and lapidary have become a panacea for all marital issues, these activities have made us feel lucky to be a couple. It's such a pleasure to have an enthusiastic partner who is eager to see the latest slab from the saw, brought onto the patio all oily and dripping. For both of us, the hobby would be nearly meaningless without the sharing.

Before I can proceed with the tale of how rocks enhanced my love affair with my wife, I must first recount how I fell in love with rocks. I grew up amid the celery fields three miles east of Arroyo Grande, California. I do not remember the precise moment when, as a child, I wound up being drawn to rocks. It may have been when my father took the family to meet a friend who had a beach house in the little artsy town of Cambria, north of Arroyo Grande. I must have been 8 or 9 years old. The house's picture windows had bowls of polished beach rocks decorating each sill. I remember hearing the owner talking about using a rock tumbler to polish the stones, and I wished that I, too, had a rock tumbler.

Craig Andrews works at a well-stocked silversmith's bench.

During my youth, my father always drew my attention to rocks, often bringing home odd stones from work, and he always indulged me when I showed him my own finds at the end of the day. Once, I found a perfectly smooth, rounded stone in the field where my brother and I had dug a fort. Later that day, my father explained that it was a "glacial" formed beneath a river of ice. The expla-

nation was good enough for me, and for days afterward I was showing everyone at school my glacial. Another time, I found a porous red stone that Dad dubbed "iron ore." These were new words to me, and I enjoyed reciting my technical knowledge about this rock, as well.

Even though he was no rockhound, my father always took time to nurture my budding geological interest in landforms. For her part, my mother also encouraged me. One afternoon, after I had set up a "rock shop" along my bedroom shelf, my mother came in and, with a few pennies, did some shopping, playing the curious, yet skeptical, customer as she rummaged among the chunks of local chert and flint I was selling.

Miriam Andrews prepares the crown of a cabochon on an old Crown combination machine

A succession of events and patterns conspired to ensnare me deeper and deeper into the world of rocks. First, my father relinquished his old masonry hammer to my rockhounding forays. I scoured our property, bringing worthless jaspers home in my backpack. Then, I rode my battered bicycle to our local rock shop for the first time, spending the few dollars I had earned doing weeks of chores on some small specimens and salivating over the bench of Lortone tumblers. My friends would go rockhounding with me at the creek.

My interest in rocks was growing, so for my 12th birthday, my mother bought me a double-barrel, 6-pound tumbler and a kit of charges. An aunt gave me a lapidary magazine subscription. Thus were my beginnings in lapidary. As I grew older, my mother allowed me to ride my bicycle 10 miles through the "Five Cities" west of our rural home to Shell Beach to look for jade, which I never found. One time, I found a big green rock at the beach, but a Cambria rock shop proprietor disappointed me by informing me that the rock was plain jasper, not jade. He brought out a big wedge of nephrite and educated me about the higher specific gravity of jade. The rock was probably overpriced at $60, but my father bought it even though it was a lot of money to the family.

I remember Mom and Dad taking us to Los Angeles to see old friends, and once we visited some people who were into rocks. The man took Dad and me on a tour of his rock stuff while his wife entertained indoors. He had barrels of backyard rocks and gave me samples, which I diligently labeled with medical tape. The lexicon of rock names intrigued me, and later that night, my mind swam with words that evoked the adventure of rock collecting: "Death Valley onyx," "Rainbow Ridge jasper," "Davis Creek obsidian."

My father began a home-remodeling business and took me with him to jobs on Saturdays and during summers. He paid me, and I used the money to acquire lapidary equipment and lapidary rocks such as Vaquilla agate at the rock shop in town. I began with a 12-inch slab saw that had a drop-in trim table. Then I bought a couple of 6-inch silicon carbide wheels for an old arbor my father gave me. I ground my first cabochons on those wheels, sanding them by hand with some sheets of wet-dry paper my dad had lying around and polishing them on an old towel charged with some red polish from my rock tumbler.

The following summer, I worked hard enough to buy a brand-new Crown 8-inch combination unit, complete with sanding drums and polish discs. My dad gave me an old motor, and soon the machine was operable. I spent nearly every night until bedtime making cabochons in the garage.

When I was 15, I discovered the appeals of teen social life and playing in—of all things—a rock band. As I grew up and music became my focus, my lapidary workshop, filling half of my

Miriam displays some of the prized stones she and her husband have cut

parents' two-car garage, took a back seat.

I had always intended to return to the hobby, but at some point my adult life began in earnest. The rigors of college, a too-young marriage (not my current one), a fledgling art career, and my involvement with music competed so radically for my time that rocks could not wedge themselves into my schedule. Finally, strapped for tuition funds, I submitted a classified advertisement to sell my lapidary equipment along with my rough rock materials. My folks bought it all before anyone else could.

Dad was retiring and thought he would try the lapidary hobby before he let a stranger buy his son's little rock shop. My dad dabbled with cabbing and making bola ties, but soon lost interest. This was almost 20 years ago. Several years later, my folks traded the lapidary equipment and rocks to my sister for a little Macintosh computer. My sister's husband planned to involve my nephew in the hobby, but never set up the machines. This is where we come back to the near-present and the story of how the hobby has helped my marriage.

continued on next page

A couple of years ago, my wife and I were visiting my sister's family and touring the property. As we explored a pole barn on the premises, Miriam approached the dusty machines and boxes of my old lapidary stuff in a corner.

"What is all this?" she asked.

I explained the machines and told Miriam about my history with the hobby. Then I started going through the boxes of rocks, telling Miriam what the rocks were. Some remnants of Stone Canyon jasper I had cut into cabochons when I was 13 still showed their dramatic, golden, brecciated patterns beneath the dust, evoking fond memories. Miriam's eyes lit up. Her interest was infectious, and we spent an hour going through the things with my explanations.

"I think we should buy it all," Miriam said, seeing the hobby as a good thing for our two children. The question was, would my brother-in-law want to sell? We raised the question, and a couple months later he obliged us. It did not take long to get things set up and operating smoothly. In no time, Miriam became an expert cabber. These days, she possesses a rich body of knowledge regarding the range and values of cutting materials.

What did not happen, however, was our children's involvement. We have tried various approaches to engage our kids' interest in the hobby, but, alas, it seems that rocks cannot compete with the computer and telephone for the attention of our 13- and 15-year-olds. It occurs to me that the rockhound hobby, despite my own experiences and most gem and mineral clubs' efforts to attract youth, is not so much a young person's pastime as that of a middle-aged or retired person. Yes, a youngster may exhibit a passion for the hobby, but once other, more social, activities present themselves, a youth may abandon his rock tumbler forever. I did—well, not forever, but for decades. Gem and mineral clubs may want to reassess their educational outreach priorities if their demographic focus is on youth.

Miriam and I have plunged ever more deeply into the hobby, and it has grown into a pastime we greatly enjoy sharing together. We have systematically plundered our meager financial reserves at gem and mineral shows in the process, meeting rockhounds whose backyard sales have caused a couple tons of rocks to appear in our own backyard. We now have two combination machines (with diamond wheels), so we can cab and visit together after a hard day at work. We have a rebuilt 24-inch saw, a 27-inch vibrating lap, and a fully stocked silversmith's bench. The hours just slide away from us in our little workshop. Miriam also brings her students over after school to make stones and jewelry.

Craig and Miriam Andrews have cabbed Ocean jasper, Botswana agate, chrysocolla, chrysoprase, and rare jaspers over their years in the lapidary hobby.

One day we bought James Mitchell's book *Gem Trails of Southern California*, 2nd ed. (Gem Trails Book Co., 2003). We have had many delightful rock-hunting excursions on BLM land in the Mojave Desert. Our favorite weekend getaway is Barstow, California. We leave the kids with their grandmother and drive to the desert for rockhounding. The adventure, scenery, and company are exquisite when my wife and I spend weekends doing what we enjoy most. A comfy hotel room is always a welcome respite at the end of a day of pursuing rough dirt trails. We have been known to rockhound the desert in July, but only until noon, at which time the hotel's pool seems appealing.

Sometimes the kids come along. We took them to the Haasel Geode Beds and had good luck there. Cory and Danka found the biggest geode, which exceeded 8 inches across. Cory now has it displayed in his bedroom.

I am only halfway through my career, but sometimes I fantasize about running a little rock shop somewhere with my wife when we retire. I would probably hate running a retail business, but I do enjoy rock shops. Nostalgia plays a big role in my dreaming, I think. Who does not long for the days of old?

At any rate, with the wonderful range of cutting materials, as well as the continuing tradition of field trips by clubs (especially newer clubs), plenty of space exists for others to join our wonderful hobby. Maybe there are other married couples out there wondering how to infuse a shared passion into their relationship. Lapidary and rockhounding may be the answer for them, too.

The best part of the hobby is the range of possibilities. By itself, learning about geology greatly enhances any travel experience. Cabbers can branch out into jewelry making. And once the metalsmith bug has taken hold, casting may be the next step. I can see the day coming when Miriam and I explore casting and even faceting, but for now we are content. We have chosen to focus on collecting and cutting rare jaspers (Deschutes, Biggs, Morrisonite, Poppy, Royal Imperial, etc.), but that is a challenge easier envisioned than done. We have enjoyed buying a few things on eBay, but usually cannot compete with other bidders. The Internet site has, however, turned out to be a good educational resource when learning about lapidary materials. We feel pleased to increase our collection any way we can. Rocks exhilarate my wife and me on many levels."

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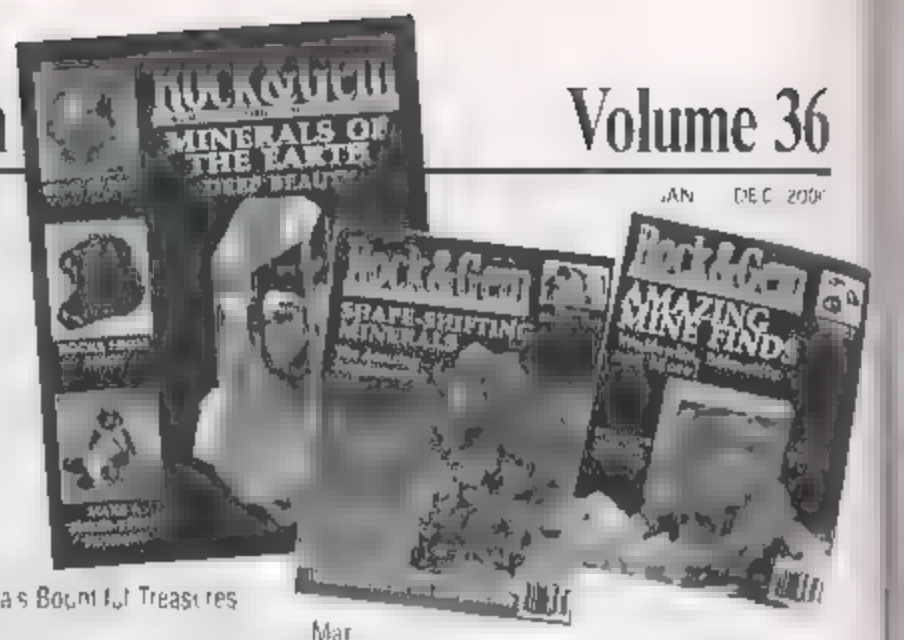

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by Steve Voynick

Rhodochrosite, Pyrolusite ... and Manganese

At first glance rhodochrosite and pyrolusite appear to have little in common. A deep-red rhodochrosite rhombohedron is infinitely more eye-catching and interesting than an opaque dull-black finger-staining piece of massive pyrolusite. Yet, the base element of both these minerals is the same: manganese. Rhodochrosite is manganese carbonate ($MnCO_3$), while pyrolusite is manganese dioxide (MnO_2).

Although rhodochrosite may be the best-known manganese-containing mineral, pyrolusite is the primary ore of manganese. Manganese is a metal with properties similar to those of iron. It has the same gray-white color but it is harder and more brittle. Manganese is also more chemically active: it is not found in its elemental form on Earth, but does occur as a native metal in meteors.

Pyrolusite is the pigment in the black paint with which Neolithic artists created Europe's 17,000-year-old cave paintings. Later the ancient Egyptians and Romans used pyrolusite in glassmaking, adding small quantities to remove color and larger quantities to impart dark colors. The exceptional hardness of the iron weapons of ancient Greece is thought to be due to the accidental incorporation of manganese into molten iron.

Swedish chemists Carl Scheele and Johann Gottlieb Gahn isolated manganese in 1774 and differentiated it from iron as a new element. Because it could be magnetized (but only with difficulty), it was named manganese after the Greek *magnēs* or magnet.

The first high-quality modern steels introduced in the early 1800s contained manganese. Previously, carbon was used to harden steel, but these alloys often proved too brittle for many applications. When metallurgists turned to manganese, the resulting alloys were less brittle and much harder and tougher.

Since that time, the most important use of manganese has been as an alloying agent. Because the atomic radii of iron and manganese are almost identical, manganese atoms can substitute for iron without distorting the iron crystal lattice, the primary cause of brittleness in steel alloys. Accordingly, manganese is an ideal flowing agent for iron, creating nonbrittle steels with increased hardness, durability, toughness, and corrosion resistance. Furthermore, manganese enhances iron's ability to take on the desirable qualities of such alloying metals as molybdenum, vanadium, and chromium.

Most modern steels contain some manganese. The addition of about 2 percent manganese hardens steel, while larger amounts toughen the alloys. Safes and bank vaults are fabricated from steel alloys containing about 12 percent manganese. Manganese is also used in nonferrous alloys. Manganese bronze (manganese, tin, copper, and zinc) is a corrosion-resistant alloy used in marine propellers and hull fittings, while manganin (manganese, copper, and nickel), an alloy in which thermal change does not affect electrical conductivity, is used in precision electrical meters. Manganese also improves the durability and strength of aluminum.

Synthetic manganese dioxide is the electrolytic paste in carbon rod dry-cell batteries. Other manganese compounds serve as paint and ceramic pigments, decolorizing agents for glass manufacturing, and gasoline antiknocking additives. Manganese compounds are also important in the electrolytically applied corrosion-resistant "bluing" on firearms. Other manganese compounds serve as powerful oxidizing agents in chemical manufacturing.

Some 10 million metric tons of manganese are now mined each year, 90 percent of which is alloyed with steel. The leading manganese producers are South Africa, Gabon, Brazil, Ukraine, and Australia.

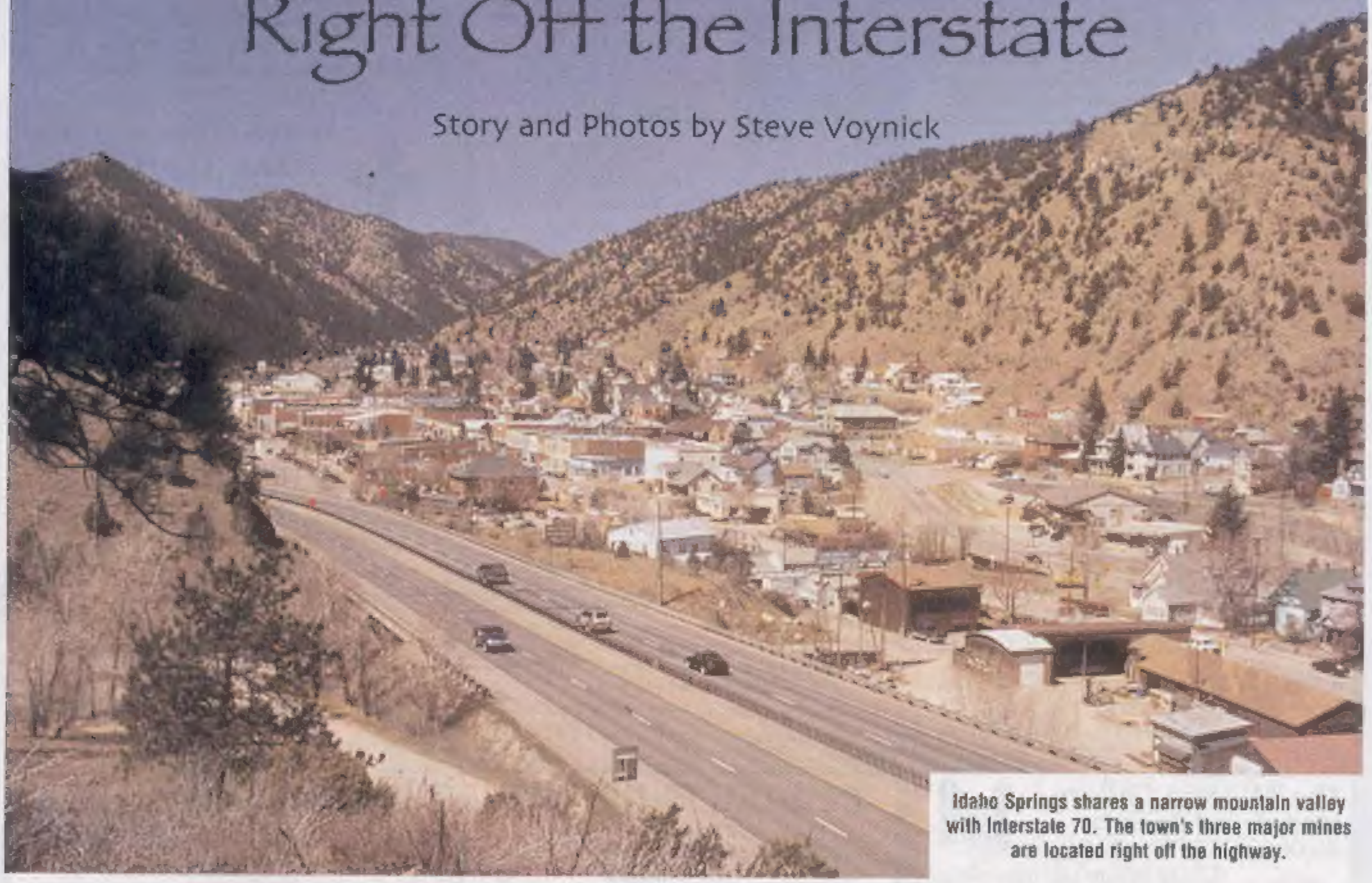
Manganese has five common oxidation states (+2, +3, +4, +6, and +7), two of which determine the coloration of manganese minerals. In its +4 oxidation state, manganese forms dull, black minerals like pyrolusite. But in its +2 oxidation state, manganese is responsible for the bright red color of rhodochrosite and the delightful rose color of rhodonite (calcium manganese silicate).

Although most of us will never see metallic manganese, the element is always close by, either in steel alloys or as the chromophore in some of our most beautiful minerals.

Idaho Springs, Colorado

Gold Mines, Mills and Minerals Right Off the Interstate

Story and Photos by Steve Voynick



Idaho Springs shares a narrow mountain valley with Interstate 70. The town's three major mines are located right off the highway.

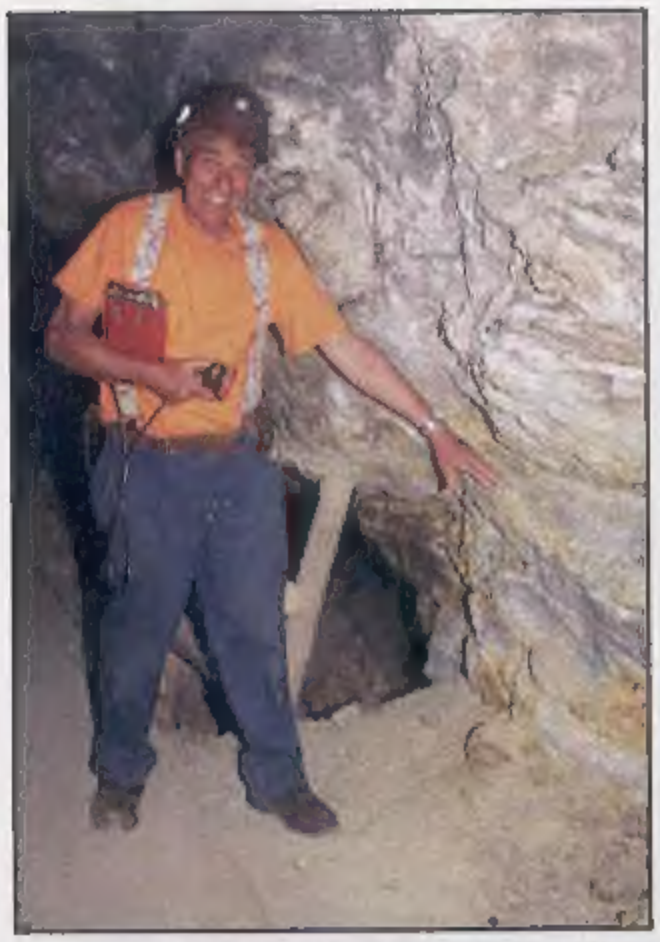
Although tucked away in the mountains at an elevation of 7,540 feet, Idaho Springs, Colorado, is not quite off the beaten path. Because it shares a narrow valley with Interstate 70, tens of thousands of people get a look at the little town every day. For most travelers, that look is only passing glance from a car window, but it's enough to tell that the history and heritage of Idaho Springs revolves around mining.

Idaho Springs is just 20 miles west of Denver. Westbound travelers first see the sprawling, bright-red Argo mill building, then a scattering of century-old mine ruins and dumps dotting the hillsides above the town, and finally the imposing Stanley Mines headframe and a sign announcing tours of the Phoenix Gold Mine. These sights often lure folks interested in mines, mills and minerals off the interstate and to the place where Colorado's gold rush began.

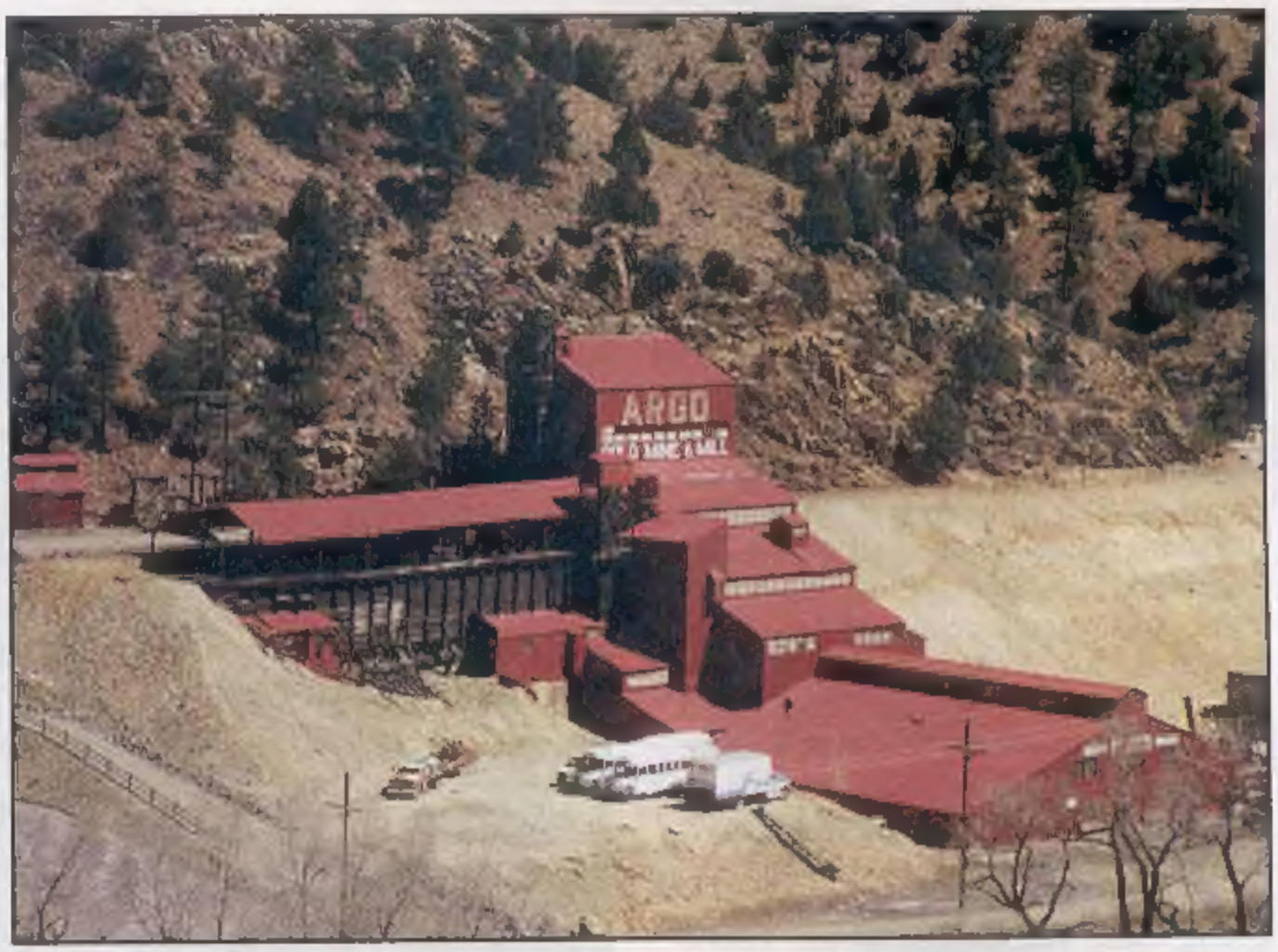
Idaho Springs has mined and milled a quarter-billion dollars worth of gold, silver, lead, zinc and copper since its first mine was established in 1859. Although the district once had hundreds of mines, only three have survived, but all are now open to the public. One is the Phoenix Gold Mine, which dates to 1871. Another is the Edgar Experimental Mine, a research and instructional facility of the Colorado School of Mines. Also welcoming visitors is the Argo Gold Mine & Mill, which showcases a less familiar—but no less fascinating—side of mining-ore processing and metal recovery.

The story of Idaho Springs began 147 years ago with a gold strike of unusual historical significance: It was not only the region's first important gold discovery, but also the strike that transformed the Pikes Peak gold rush from a debacle to a boom.

The Pikes Peak gold rush, which occurred in two distinct phases, is among the stranger events in western United States mining history. French prospectors first found gold in what is now Colorado in the 1750s. American prospectors later made small discoveries, but the find that finally triggered the first phase of the Pikes Peak rush—prematurely, as it turned out—was made in May 1858 within the present-day city limits of Denver. The gold recovered from that "strike" amounted to a mere 3 grams (about 1/10 troy ounce).



At Mosch left parts of the Resurrection Vein intact so visitors could see what a high-grade gold vein looks like.



The Argo Gold Mine and Mill at Idaho Springs processed ore from dozens of mines for over 40 years.

But after this trifling amount of gold was brought to Westport, Kansas Territory (now Kansas City, Kansas), and dramatically "re-panned" before a wide-eyed audience, eastern newspapers ran grossly exaggerated stories that started the rush. By fall, some 50,000 hopeful gold miners had surged across the Plains to the Denver-area settlements. Once there, they learned the sad truth: less than 100 troy ounces of gold had been recovered during all of 1858.

By spring 1859, thousands of bitterly disappointed gold-seekers had already given up and were heading back east across the Plains, not knowing that the desperately needed bonanza strike that would redeem the rush had already been made—but not reported.

It all started several months earlier in January 1859, when George A. Jackson, a Missouri trader, left the Denver settlements and made his way alone into the Rockies on a hunting trip. On the South Fork of Clear Creek, he camped at a hot spring near the mouth of a stream that would soon be named Chicago Creek. After building a fire atop a frozen gravel bar, Jackson decided to look for gold. Not equipped for serious prospecting, he simply scraped out some thawed dirt and "panned" it in his tin drinking cup. The gravel was so rich that a dozen cups yielded 1 troy ounce of gold.

"If only I had a pick and a pan instead of a hunting knife and a cup," Jackson wrote that night in his diary, "I could dig out a [sackful] of the yellow stuff."

After arriving back in Denver a week later, Jackson revealed his strike only to a trusted few. Jackson and his partners returned to the site in April and in just five days washed out more than 100 troy ounces of gold worth $1,900.

Jackson finally revealed his discovery in Denver in early May 1859. His announcement, together with that of a more recent nearby strike at the future site of Central City, sent hordes of prospectors surging into the Rockies.

The settlement of Jackson's Diggings, soon to be renamed Idaho Springs, quickly became Colorado's first real gold camp. Within months, prospectors had fanned out through the Rockies to make a remarkable succession of rich strikes at places like Fairplay, Tarryall, Empire, Alma, Breckenridge, and Oro City (later Leadville).

While working their placers, the first Idaho Springs miners also found outcrops of gold-rich quartz, which they crushed with hammers and sluiced to recover the gold. Gold production increased rapidly when miners erected steam-powered stamp mills to speed the work of crushing. By the end of 1861, the Idaho Springs placers and small lode mines had yielded 30,000 troy ounces of gold worth well over $500,000.

But both the placers and quartz lodes depleted quickly. Miners found much more mineralization at depth, but the metals were locked within complex sulfide ores that were not amenable to the crude milling technologies of the day. Accordingly, metal production at Idaho Springs and other Colorado mining camps declined sharply over the next decade.

After the introduction of dynamite, mechanical rock drills, and improved milling techniques in the 1870s made it possible to mine and mill the deep sulfide ores, metal production at Idaho Springs increased steadily. But by 1890, the mines were so deep that dewatering, ventilation, and ore haulage became serious problems. In 1893, miners started construction of a mill-tunnel complex to serve dozens of mines. When the project was completed in 1910, the 4.5-mile-long, slightly inclined Argo Tunnel (also known as the Newhouse Tunnel) drained and ventilated many mines. It also provided a downgrade haulage route to efficiently deliver the ores from many mines to the new Argo Mill, then the West's largest and most modern metallurgical mill. The Argo tunnel-mill complex would greatly extended the life of the Idaho Springs mining district.

By that time, geologists had learned that emplacement of Idaho Springs-area ores had begun with extensive block faulting associated with the Laramide Orogeny, the mountain-building episode that uplifted the modern Rockies some 65 million years ago. Forced upward by great pressure, magma intruded the faults, solidifying into dikes and sills of porphrytic quartz monzonite. These intrusions created secondary fractures that filled with superheated mineral-bearing solutions to form systems of vein- and stockwork-type ore bodies.

The primary ore minerals at Idaho Springs are galena (lead sulfide), sphalerite (zinc sulfide), and chalcopyrite (iron copper sulfide). The ores, which all contain substantial amounts of gold and silver, fall into four groups: pyritic; galena-sphalerite; a transitional pyritic-galena-sphalerite; and telluride, in which gold and silver are combined with tellurium. In all the ores, gold is the metal of primary economic importance.

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The mines and mills of Idaho Springs produced steadily until World War II, when a federal directive closed all mines in which gold was the primary economic product. In 1943, the Argo Mill, facing dwindling mine production as well as a flooded tunnel, shut down permanently.

Post-war inflation drove mining costs higher, but the price of gold remained fixed at $35 per troy ounce. Furthermore, miners now had the added expense of shipping their ores to distant mills. Accordingly, relatively few mines reopened. By 1970, costly, mandatory compliance with new environmental regulations proved to be the last straw. Most small mines in Idaho Springs, as well as in many other Western mining districts, closed for good.

At time when many small miners were giving up, third-generation Idaho Springs miner Alvin "Al" Mosch decided to buy a mine. Al's grandfather, Rudolph Gerhardt von Mosch, had emigrated from Germany in 1887, arriving in Idaho Springs to work as a miner. Later, Rudolph's son Hans also went into mining. In the 1950s, Hans taught hardrock mining to his son Al. Over the years, Al went on to work in mines in Idaho Springs and in other mining camps in Colorado and Utah.

Idaho Springs was Al's home, though, and that's where he wanted to stay. By 1972, Al realized that if he were going to work as miner in Idaho Springs, he would have to buy his own mine. In 1972, he purchased the Phoenix, a gold mine with a rich history.

The Phoenix Mine is named for the Phoenix Vein, an outcrop of which was discovered in 1871. Because veins tend to be erratic, production from mines working vein-type ore deposits, including the Phoenix Mine, is often unpredictable. On average, the Phoenix Vein carried about 6 troy ounces of gold per ton. In places, it "blew out" to considerable width, but it could also "pinch out" to nothing. Initially, the mine was a steady producer and earned a big profit, but when the vein pinched out in 1930, so did the profits. The mine was sold for just $20 in back taxes.

A shady real-estate agent subsequently bought the mine, salted it, and re-sold it to two Minnesota farmers for $5,000. As it turned out, the farmers' luck more than compensated for their mining inexperience. They extended the main drift just 40 feet before intersecting a new, rich vein section, then sank a winze 100 feet to a point where the vein "blew out" to a width of 11 feet. Also, just as gold production increased sharply, the federal government raised the price of the

Over a period of 147 years, the mines and mills around Idaho Springs, Colorado, produced and processed some $250 million in gold and other metals.

metal from $20.67 to $35 per troy ounce, making the Phoenix a big money-maker once again.

The Phoenix shut down during World War II, but mining did not resume immediately after the war. It finally reopened in the 1950s, only because two miners leased the mine to "clean up" the stopes and haulage drifts. The "loose" gold they recovered added up to a solid profit.

The Phoenix then remained idle for 15 years until Al Mosch bought it in 1972 for $5,000. Al planned be very selective in his mining, exploiting small veins of high-grade ore to minimize operational costs and environmental concerns and to get by with only a small crusher and concentrator.

Just as Al had learned mining from his father, he passed along his skills to his son David. At age 14, David found an outcrop of previously undiscovered gold vein. Al and David then drove a drift to intersect the narrow vein, which they named the Resurrection Vein. Carrying a remarkable 20 troy ounces of gold per ton, the Resurrection Vein, as Al says, "paid the bills" for many years.

Later, Al continued selective vein mining, but also opened the main drifts of the Phoenix to public tours. Today, his Phoenix Gold Mine hosts several thousand visitors per year.

I met Al at the Phoenix Gold Mine on an April afternoon. Although tourist season was still weeks away, Al's day had been busy. He had already hosted a 72-student class trip and a dozen other visitors, but he was still ready to discuss his favorite topic: hardrock mining.

"It's important to keep some mines open to the public," Al said. "In Idaho Springs, mining is our history and heritage. And the Phoenix Gold Mine is a direct tie to that history."

The underground, single-level tour of the Phoenix takes about an hour and imparts a good sense of what small-scale, underground gold mining is all about. Al and his tour guides lead visitors through drifts that are "bald-headed" (not timbered) in places, and heavily timbered in others. The tour passes cavernous overhead stopes created by the removal of thousands of tons of Phoenix Vein ore, an internal ore chute, and a steeply declined winze leading to another level 100 feet below.

Visitors can try their skill at hand steeling, the traditional manual technique of drilling blast holes in solid rock using hammers and chisellike hand steels. They can also examine and photograph rail-mounted ore cars, small crushers, ball mills for grinding ore, a shaker table for gravitation separation of ground ore, and both modern and frontier-era rock drills, including a 300-pound, 130-year-old mechanical drill called a "widowmaker."

"Because these drills didn't use water, they churned up clouds of rock dust," Al explained. "Inhaling this dust caused silicosis, an often-fatal condition that literally petrified the miners' lungs—hence the name widowmaker."

Visitors can actually touch the Resurrection Vein's high-grade gold ore. Cutting across the roof and walls of the underground mill room, this blue-green vein ranges in width from several inches to about 1 foot.

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"I left parts of this vein intact to show folks just what a high-grade gold vein looks like," Al said. "The color is due to high copper content. But it's the gold content—about 20 troy ounces per ton—that makes it special. Today, ore like this is a true rarity."

The Resurrection Vein illustrates the element of luck that has always been a big part of vein mining. Actual mining is the only way to "prove" the vein, which might maintain its apparent width, pinch out entirely, or blow out into a massive structure of bonanza ore.

Al has also welcomed a number of film crews to the Phoenix Gold Mine. It has served as a backdrop for scenes in several television and motion picture productions, including television's "Unsolved Mysteries" and the motion picture "Silver City" (Independent, 2004).

Admission to the Phoenix Gold Mine is $10 for adults and $5 for children ages 5 to 11. Admission includes gold panning in Trail Creek, which flows right through the Phoenix property. Trail Creek was a big producer in the 1860s and still yields good color.

After touring the Phoenix, head to the Argo Gold Mine & Mill for a walk through the Double Eagle gold mine and a look at exhibits that span a century of ore-milling technology; they include stamp mills, mill-feed decks, grinding mills, classifiers, shaker and amalgamation tables, flotation cells, and cyanidation systems. Open daily from mid-April through mid-October, the Argo is a great place to learn about what happens to ore after it's mined. Admission is $15 for adults and $7.50 for children ages 7 to 12. The tour includes live demonstrations of drilling, ore crushing, and various milling procedures, as well as instructional gold panning.

Another nearby site of interest is the Edgar Experimental Mine, which once produced high-grade gold-silver-lead-copper ore. The Colorado School of Mines acquired the mine in 1921 as a research facility and instructional site for students of mining engineering. Today, the Edgar Experimental Mine serves as an underground laboratory for research in mining techniques and systems, and as a "hands-on" classroom for Colorado School of Mines students, a site for industrial testing, and a mine-rescue and mine-safety training facility.

Alvin "Al" Mosch, owner and operator of the Phoenix Gold Mine and a third-generation Idaho Springs gold miner, welcomes visitors at the mine portal.

Visitors walk through a half-mile of tunnels with exhibits of frontier-era and modern mining equipment, while knowledgeable tour guides discuss everything from mining economics to the role of mining in modern society. From June through August, the daily tour begins at 1 p.m. During the rest of the year, group tours must be arranged in advance. Admission is $6 for adults, $4 for seniors, and $3 for ages 6 to 16.

The manager of the Edgar Experimental Mine is David Mosch, who as a youngster discovered the Resurrection Vein at the Phoenix Mine. Dave has taken his family's mining tradition to new heights and is now a mining engineer and instructor at the Colorado School of Mines.

Despite extensive reclamation work over the past two decades, field mineral collectors can still find many old mine dumps in the mountains immediately north of Idaho Springs. Most dumps are stained with yellow iron hydroxide, an oxidation product of pyrite. Splitting larger pieces of dump rock, however, can expose unoxidized interiors with crystals of pyrite and other ore minerals such as galena, sphalerite and chalcopyrite. Also common are specimens of tennantite, an arsenic-rich copper iron sulfide.

History buffs will enjoy visiting the place where Colorado gold mining really started, the mouth of Chicago Creek, where George Jackson filled that tin cup with thawed gravel and struck it rich. The site is marked by the Jackson Memorial, a stone monument and commemorative plaque located immediately south of I-70 at Exit 240.

I-70 travelers interested in mining and minerals would do well to exit at Idaho Springs. There's a wealth of mining history here, and it's all conveniently located right off the interstate. Although Idaho Springs is only two miles long, it is served by three exits, numbers 239, 240 and 241. Take any of these exits and follow the signs to the Heritage Visitor Center & Museum at 2060 Miner St. The Visitor Center provides information and maps, while the adjoining museum (free admission) displays mining equipment, mineral specimens, and local ores.

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